

POCKET
OPTICAL DICTIONARY
AND
ENCYCLOPEDIA

THIRD EDITION
LEWIS

REVISED MAY 1, 1909

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POCKET
Optical Dictionary

INCLUDING

Pronunciation *and* Definition

OF THE

WORDS

USED IN

Optometry *and* Ophthalmology

Together with a complete description of the light wave theory, Anatomy of the Eye, functions and nerve supply of the different parts, Retinoscope, Ophthalmoscope, Trial Case and how to use them. Transposition, Toric and other lenses.

By JAMES J. LEWIS, Oph. D.

Professor of Optometry in the Northern Illinois College of
Ophthalmology and Otology.

THIRD EDITION

Revised and Enlarged Illustrated
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To the Public:

This edition has been compiled with a great deal of care. Realizing that perfection in its full sense has never been attained by mortal man, the author invites the unbiased and conscientious criticism of the readers and users of this Dictionary and hereby earnestly solicits the same to the end that the future editions may profit by the honest convictions of studious oculists, physicians and optometrists.

I cannot conclude without expressing my deep sense of obligation to the profession for their kind reception of this work. Feeling the responsibility incurred by those who attempt to teach others, I have spared no amount of labor or cost to render this volume clear, practical and useful.

Very respectfully,

THE AUTHOR.

P R E F A C E

TO THE THIRD EDITION

The second edition of this work has met with so much favor, that the Author has attempted to revise it, and in this way make it more worthy of the commendation of the profession. Many definitions have been rewritten, and about twenty pages of new matter has been added in the form of an appendix.

I wish to express my appreciation for the efficient assistance extended by

J. B. MCFATRICH, M. S., M. D.,

Professor of the Principles of Ophthalmology
and Otology.

GEO. WILBUR MCFATRICH, M. D.,

Professor of Clinical and Didactic Ophthalmology
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HENRY S. TUCKER, A. M., M. D.,

Professor of Anatomy and Physiology of the Eye
and Brain.

I particularly acknowledge the assistance of my friend, Dr. G. W. McFatrigh, whose knowledge, gained through experience as Professor of Ophthalmology in Medical Colleges and as Oculist to Hospitals in Chicago and large professional practice in Diseases of the Eye, has been freely placed at my command in bringing this little book to the highest possible standard.

J. J. L.

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ABBREVIATIONS AND OPTICAL SIGNS.

Acc.....	Accommodation.
Aet.....	Age.
Am.....	Ametropia.
An.....	Anisometropia.
As.....	Astigmatism.
Asth.....	Asthenopia.
Ax.....	Axis.
Cc. or — (minus).....	Concave.
Ce.....	Centigrade.
Cm.....	Centimeter.
Cx. or + (plus).....	Convex.
Cyl.....	Cylinder.
D.....	Diopter.
D. Cc.....	Double concave.
D. Cx.....	Double convex.
D. T.....	Distance test.
E. or Em.....	Emmetropia.
H. or Hy.....	Hypermetropia.
In.....	Inches.
L. or L. E.....	Left eye.
M. or My.....	Myopia.
Mm.....	Millimeter.
N.....	Nasal.
Nv.....	Naked vision.
O. D. (Oculus Dexter).....	Right eye.
O. S. (Oculus Sinister).....	Left eye.
O. U. (Oculi Unati).....	Both eyes.
P. or Pb.....	Presbyopia.
P. Cc.....	Periscopic concave.
P. Cx.....	Periscopic convex.
P. D.....	Inter-Pupillary distance.

ABBREVIATIONS AND OPTICAL SIGNS—Con.

Pl...	Plano.
p. p. (Punctum Proximum)	Near point.
p. r. (Punctum Remotum)	Far point.
Pr.....	Prism.
R. or R. E.....	Right eye.
R. T.....	Reading test.
Rx.....	Prescription.
Sb.....	Strabismus.
S. or Sph.....	Spherical.
T.....	Temporal.
Ty.....	Type.
V.....	Vision.
Va.....	Visual acuteness.
W. P.....	Working point.
+	Plus convex.
—	Minus —concave.
○	Combined with.
°	Degree.
△	Prism Diopter.
=	Equal to.
∞	Infinity, 20 ft. or farther.
///	Line, 12th part of inch.

Should the word not be found in alphabetical order, refer to the appendix.

When this sign * is found at the end of a definition, refer to the same word in the appendix.

Lewis Pocket Optical Dictionary.

Abaxial (ab-aks'-e-al). Not situated in the line of the axis.

Abducens (ab-du'-senz). Refers to the sixth pair of nerves that control the movement of the external rectus muscles. They are the straight muscles, sometimes called the abducens muscles, located on the temple side of the eyeball, which turn the eye outward, and under normal conditions these muscles should overcome about 8 degrees of prism, base in.

Abduct. To draw away from the median line.

Abduction (ab-duc'-shun). The act of turning the eye outward. For testing the power of the abductors or external recti muscles, use the strongest prism, base in, with which the eye can overcome diplopia.

Abductor (ab-duc'-tor). Any muscle that abducts. For instance, the external rectus.

Aberration (ab-er-a'-shun). Wandering from normal. When applied to lenses would mean, unable to obtain a perfect focus. It is due to the greater refractive power of the edge over the center of convex lenses, thus causing the image to be somewhat blurred. In the eye the iris shuts off the edge of the lens, and in this way prevents spherical aberration. **Chromatic Aberration**, dispersion of colors. Owing to the colored rays having different degrees of refractibility they are not focused at the same distance.

Ablatio-retinae (ab-la'-she-o-ret'-in-e). Detachment of the retina.

Ablepharia (ah-blef-ar'-e-ah). That condition in which the eyelids are absent.

Ablepsia (ah-blep'-se-ah). Blindness—want of sight

Abnormal. Away from normal. Relating to vision would mean, any defect of sight. (**Ametropia**.) An eye wherein parallel rays of light do not focus on the retina with the muscles of accommodation at rest.

Abrasio-cornea (ab-ra'-sio-cor'-ne-ah). The rubbing off of the outer layer of the cornea.

Abscess (ab'-ses). A collection of pus in any cavity formed by the separation of tissue.

Absolute Index of Refraction is that which is found when light passes from a vacuum into a given medium.

Absorption (ab-sorp'-shun). A term applied in the operation for cataract where the lens capsule is needed, allowing the aqueous humor to absorb the lens.

Absorptive. Anything that has the power of absorption.

Accommodation. The power to adjust the eye to see within its far point. It takes place by contracting the ciliary muscles which encircle the lens and draws forward the choroid and hyaloid membrane, the suspensory ligaments becoming relaxed, and the lens (by its own elasticity) allowed to assume a greater convexity,

especially its anterior surface, thus increasing its refraction. Amplitude of Accommodation (from Landolt) as follows:

Age in Years	Amplitude (dioptries)
10.....	14
15.....	12
20.....	10
25.....	8.5
30.....	7.0
35.....	5.5
40.....	4.5
45.....	3.5
50.....	2.5
55.....	1.75
60.....	1.0
65.....	0.75
70.....	0.0

This is approximately correct, but individuals differ in the amount of accommodation they possess at the same age.

Achroma. Without color.

Achromatic Lens (ah-kro-mat'-ik). (See Lens.)

Achromatism (ah-kro'-ma-tism). Absence of chromatic aberration.

Achromatopsia (ah-kro-mat-op'-se-ah). Color-blindness.

Achromatosis (ah-kro-mat-o'-sis). Any disease marked by lack of pigmentation.

Acorea (ah-ko'-re-ah). When the pupil is absent.

Acquired. Not born with, but developed after birth.

Acuity (ak-u'-it-e). Sharpness, like a needle. The sharpness of vision; the keenness of the visual powers. The acuteness of vision means the vision the patient has with his full correction. The faculty of the retina to perceive forms depends on many conditions—

1. Primarily, on the sensibility of the retina.
2. On the adaptation of the retina.
3. On the general illumination.
4. On the sharpness of the retinal image.
5. On the intensity of the illumination.

It is known that the acuteness of vision varies with the general illumination up to a certain degree of intensity, as that of a clear, sunny day; the two then vary in a direct proportion, but when the illumination passes a certain limit of intensity, the acuteness of vision diminishes instead of increases.

Adaptation (ad-ap-ta'-shun). Adjustment of the pupil to light.

Adducens (ad-du'-sens). When this term is applied to the eye it means the internal rectus muscle, the muscle which turns the eyeball inward toward the nose. The power of adduction of the eye ranges from twenty up to fifty degrees. For testing the power of the adducens or internal rectus muscle, use the strongest prism, base out, with which the eyes can overcome diplopia.

Adduct. To draw inward toward a center.

Adduction. Movement of the eyeball inward. The adducens means the internal rectus muscle by which we turn the eyes inward. The test for the power of the adducens is made by placing the

base out of the strongest prism with which the eyes can overcome diplopia.

Adenectomy (ad-en-ek'-to-me). Removal of a gland by operation.

Adenemphraxis. That condition in which the duct or gland is obstructed.

Adenoid (ad'-en-oid). Resembling a gland.

Adenophthalmia (ad-en-off-thal'-me-ah). Inflammation of the meibomian glands.

Advancement. The cutting away of a muscle of the eye and attaching it to an advanced point. This operation is performed on the weak muscle in cases of strabismus.

Adventitious (ad-ven-tish'-us). Acquired—not normal.

Albinism (al'-bin-ism). Abnormal deficiency of pigment in the iris and choroid.

Albugo (al-bu'-go). White opacity of the cornea of the eye. Leukoma.

Alexia (a-lex'-ia). Unable to read, due to a central lesion.

Amaurosis (am-aw-ro'-sis). A disease of the optic nerve or retina, which causes blindness.

Ambiopia (am-be-o'-pe-ah). Vision with both eyes.

Amblyopia (am-ble-o'-pe-ah). A dimness of vision from defective sensibility of the retina. A condition in which there is a possibility of restoring the former vision; for instance, when a person has an error of refraction in one eye, the other eye being emmetropic, he will learn to ignore the eye with the error, and use the one with the

best vision. In this way the sight will become dim from want of use, and is an acquired state, which by testing with the pinhole disc will show no improvement. Under these conditions, the error must be corrected with the retinoscope, and if the eyes are not more than two diopters apart instruct your patient always to wear his correction and cover the good eye two or three times a day, for a period of ten minutes at a time, and try to use the amblyopic eye. In this way you will notice an improvement each week. When the pinhole disc fails to improve vision, the eye is either amblyopic or in a diseased state. **Toxic Amblyopia** is a dimness of vision from the poisonous effect of drugs, such as quinine, upon the nervous system—excessive use of tobacco or alcoholic stimulants produce the same effect. The treatment for this form of Amblyopia does not consist of glasses, but the patient must quit the use of the drug causing the trouble, and if not too far advanced there is a possibility of recovering the former vision. **A., Postmar'ital**, that due to sexual excess. **A., Crossed**, on one-half of retina.

Amblyopia ex Anopsia. Amblyopia resulting from one eye having been excluded for some time from binocular vision.

Ametrometer (a-met-rom'-e-ter). An instrument used for measuring ametropia.

Ametropia (a-met-ro'-pe-ah). Any error of refraction, such as hyperopia, myopia, or astigmatism.

Amphice'lous. Concave on both sides or ends.

Amphodiplopia (am-fo-dip-lo'-pe-ah). That condition where both eyes have double vision.

Amplifier (am'-ple-fi-er). An apparatus for increasing the magnifying power of a microscope.

Amplitude of Accommodation. The power or force necessary to change the eye from its far point to its near point (or from its punctum remotum to its punctum proximum). (See Accommodation.)

Amplitude of Convergence. The power or force necessary to turn the eyes from their far point to their near point of convergence. It is represented by the greatest number of meter angles of convergence that the eyes can exert.

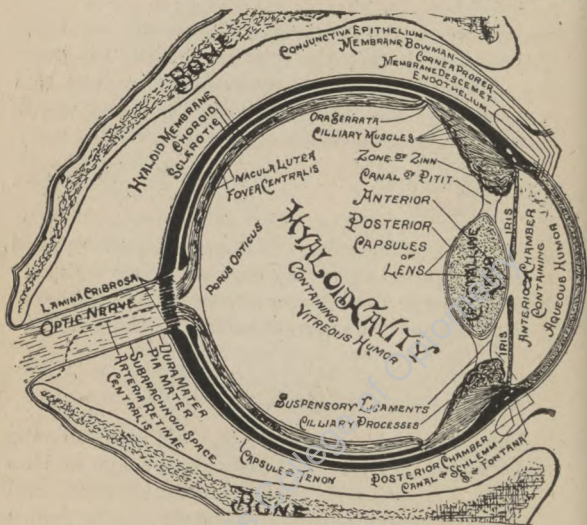
Anacamptom'eter. An instrument for measuring the reflexes.

Anaclasis (an-ak'-las-is). When this term is applied to light, it refers to the rays traveling obliquely from a rarer to a denser media, being bent backward toward the perpendicular (refraction).

Anaesthesia (an-es-the'-ze-ah). Lacking sensitiveness, where the retina is amblyopic.

Anatomy (an-at'-o-me) (**Eye**). Relates to the description of the structures of the eye and its parts. The eyeball is nearly spherical in shape and measures about 24 mm. in diameter. The cornea represents a segment of a small sphere projecting from its anterior surface. The first tunic of the eyeball is the sclerotic and cornea. The posterior five-sixths is the sclerotic, which is white and opaque, and serves to give shape to the eye and protects its more delicate interior. Near the posterior pole, on the nasal side, is a sieve-like disc known as the lamina cribrosa, through which

the optic nerve fibers enter the eye. The sclerotic is thickest at its posterior portion and gradually becomes thinner as it approaches the equator, and again thickens as it approaches the cornea. The anterior one-sixth is the cornea. It is transparent and of a greater curvature than the sclerotic. The cornea is set in the sclerotic as



a watch crystal is placed in its frame and is composed of five layers. From without inward as follows: Conjunctiva Epithelium, Bowman's membrane, Cornea proper, Membrane of Descemet, and the Endothelium. At the inner angle (angle of filtration) between the iris and cornea, there are a number of comb-like openings which are in the trabecular tissue or pectinate ligament

which runs from the periphery of the cornea to the base of the iris. These openings are called the spaces of Fontana, through which the aqueous humor passes into the canal of Schlemm, a circular canal extending around the periphery of the cornea at the sclero corneal junction, but entirely within the cornea. From this canal the humor passes into the anterior ciliary veins. The second tunic of the eye is composed of the choroid, ciliary body and the iris. It lines the inner side of the sclerotic, and is perforated to allow the optic nerve to enter, and has a circular opening in front, which is known as the pupil. Through this tunic the eye obtains its principal blood and nerve supply. This is the tunic in which the pigment is deposited for the purpose of absorbing light. The choroid is said to nourish the retina and the vitreous. The ciliary muscles are within the ciliary body, and are used for accommodating. The iris is the most anterior portion of the second tunic. It is located in front of the crystalline lens, and separates the posterior and anterior chambers; it gives the eye its color, regulates the amount of light which enters, and prevents spherical aberration of the lens. The third tunic is the retina. It is a very delicate, transparent membrane, made up of ten layers, one of which is the layer of optic nerve fibers. These fibers pass through the lamina cribrosa at the optic disc, and flatten out more and more as they approach the front of the eye. The retina is attached in two places, at the optic disc and at its anterior border, the ora serrata. It is not attached to the choroid, but simply lies on it. In examining the retina with the ophthalmoscope you will



A CUT THROUGH THE CILIARY BODY.

O, Cornea; Scl, Sclerotic; Ch, Choroid; R, Retina; or, Ora Serrata; Z, Zonule of Zinn or Suspensory Ligaments; ii, Petit's Canal; p, Edge of Pupil; P, the most prominent part of the Ciliary Process; sp, Sphincter Pupillae Muscles; s, Canal of Schlemm; L, Conjunctiva; B, Lens; l, Angle of Filtration.

notice the optic disc on the nasal side which marks the entrance of the optic nerve into the globe. The macula lutea, which is the most sensitive spot of the retina (sometimes called the yellow spot, as it is said to turn yellow after death), is situated slightly on the temple side. The functions of the retina are to receive the impressions of the waves of light and transmit them through the optic nerve to the brain. The space between the iris and cornea is known as the anterior chamber of the eye, and that between the iris and the lens as the posterior chamber. Both of these chambers are filled with a transparent, watery fluid known as the aqueous humor. The large chamber back of the crystalline lens is known as the vitreous chamber, and contains the vitreous humor which occupies a little more than three-fourths of the eyeball. It is a perfectly transparent substance about the consistency of the white of an egg, and is enclosed in a thin transparent sac known as the hyaloid membrane. This membrane divides at the ciliary body and forms what is known as the anterior and posterior suspensory ligaments, which are attached to the lens capsule, thus forming what is known as Petit's Canal and the Zonule of Zinn. Within the lens capsule the crystalline lens is to be found. In shape the lens resembles a bi-convex lens, except that it is less curved in front than behind; in youth it is highly elastic, moderately firm, yet a perfectly transparent body, as clear as a crystal, and as we grow older it becomes harder and sometimes of a slightly straw tint. The crystalline lens is made up of layers closely resembling those of an onion, which accounts for its

elasticity. The eyeball is imbedded in the fatty substance of the orbit, and is surrounded by a thin membranous sac, which isolates it and at the same time allows free movement. This sac is named the Capsule of Tenon. It is a very delicate membrane consisting of two layers which invest the posterior part of the globe from the margin of the cornea backward to the entrance of the optic nerve, and is connected to it by a very delicate connective tissue. Both layers are lined on the inner surface by endothelial cells. The cavity between them is continuous with the space between the two layers of the sheath of the optic nerve, which is known as the subarachnoid space. The inner layer is known as the pia mater, and the outer as the dura mater, and between them empty the lymphatic vessels of the sclerotic. This capsule is penetrated by the (tendon) muscles of the eyeball near their insertion, which spread out fan shape, and are attached to the sclerotic.

Anatomist (a-nat'-o-mist). A person who is skilled in anatomy.

Anatomy of Orbits. The orbits are two pyramidal cavities, situated at the upper and anterior part of the face, their bases being directly forward and outward and their apices backward and inward, so that the axes of the two if continued backward would meet over the body of the sphenoid bone. The orbit is lined with periosteum, the periorbita. Each orbit is formed of seven bones, the frontal, the sphenoid, ethmoid, superior maxillary, malar, lachrymal, and palate; but three of these, the frontal, ethmoid, and sphenoid, enter into the formation of both orbits,

so that the two cavities are formed of eleven bones only. The orbital opening, or mouth, is called *aditus orbitae* (*Aditus Orbitae*—entrance to orbit). At the apex, or back part of the orbit on the nasal side, is a small circular opening known as the optic foramen, which transmits the optic nerve and ophthalmic artery. There are nine openings communicating with each orbit, viz., the optic foramen, the sphenomaxillary fissure, sphenoidal fissure, supraorbital foramen, anterior and posterior ethmoidal foramina, infraorbital canal, malar foramina, and the canal for the nasal duct. Sphenomaxillary fissure transmits the superior maxillary nerve and its orbital branches, the infraorbital vessels, and the ascending branches from the sphenopalatine or Meckel's ganglion. Sphenoidal fissure transmits the third, the fourth, the three branches of the ophthalmic division of the fifth, the sixth nerve, some filaments from the cavernous plexus of the sympathetic, the orbital branch of the middle meningeal artery, and a branch from the lachrymal artery of the dura mater, and the ophthalmic vein. Supraorbital foramen transmits the supraorbital artery, nerve and vein. Anterior ethmoidal foramen transmits the anterior ethmoidal vessels and nasal nerve. Posterior ethmoidal foramen transmits the posterior ethmoidal vessels. Infraorbital canal opens just below the margin of the orbit. Malar foramina is a passage for nerves and vessels from the orbit.

Angle. A figure formed by two straight lines extending out from one point in different directions. **Angle Gamma** is formed at the center of

rotation of the globe by the optic axis and a line drawn from the point on the object looked at. **Angle of Convergence** is the angle which the two visual axes form in turning from infinity to a point less remote. The angle thus formed, when the two visual axes are directed to a point one meter distant on the median line, is called a meter angle of convergence, and is the unit of the angle of convergence. When the visual axes meet on the median line, at a half meter distance, it is called a two-meter angle of convergence, and when looking at a third meter distance it is called a three-meter angle of convergence. **Visual A.** is an angle formed by rays of light coming from the extremities of an object looked at and crossing at the nodal point of the eye. This angle depends for its existence upon the size and distance of the object. **A. of Incidence** is the angle formed by the incident ray with the perpendicular. **A. of View** (same as visual angle). **Optic A.** is formed by the meeting of the optic axes of the two eyes. **A. of Reflection** is an angle formed by the reflected ray with a line perpendicular to the reflecting surface, and is always equal to the Angle of Incidence.

Angle Alpha (ang'gel al'-fa). The angle formed by the optic and visual axis.

Angle of Incidence. The angle formed by the incident ray with the perpendicular.

Angle of Refraction. The angle formed by the refracted ray with the perpendicular.

Azian'thinopsy. Inability to distinguish violet shades.

Aniridia (an-ir-id'-e-ah). Congenital absence of the iris.

Anisocoria (an-is-o-ko'-re-ah). That condition where the two pupils are unequal.

Anisometropia (an-is-o-me-tro'-pe-ah). A difference of refraction in the two eyes. The defect is usually congenital, but it can be acquired, as in Aphakia, or operations of any kind. One eye may be emmetropic, the other hypermetropic, or myopic, or one more hypermetropic, myopic, or astigmatic than the other. When one eye is hypermetropic or emmetropic and the other myopic, the hypermetropic or emmetropic eye is used for distance, and the myopic eye for nearness.

Anisopia (an-is-o'-pe-ah). An inability of both eyes to receive equal impressions, not due to an unequal refractive state.

Ankyloblepharon (ang-kil-o-blef'-ar-on). Adhesions of the edges of the eyelids.

Annulus (an'-nu-lus). A ring-shaped organ. **A. ciliaris**, boundary between iris and choroid.

Anoopsia (an-o-op'-se-ah). Where the eye has turned upward. (Strabismus.)

Anophthalmia (an-off-thal'-me-ah). Absence of the eyes.

Anopsia (an-op'-se-ah). Disuse of the eye from certain defects.

Anorthopia (an-or-tho'-pe-ah). When the eyes are turned from parallelism. (Strabismus.)

Anterior (front part). Referring to the eye, the cornea would be the most anterior point.

Antimetropia (an-ti-me-tro'-pe-ah). Where one eye is myopic and the other hypermetropic.

Antiseptic (an-ti-sep'-tik). A substance which is destructive to poisonous germs.

Apex (a'-pex). The thin edge of a prism.

Aphakia (ah-fa'-ke-ah). Absence of the crystalline lens.

Apical (a'-pik-al). Pertaining to the apex.

Aplanatic (ah-plan-at'-ik). That condition where there is neither spherical nor chromatic aberration, and the lines are also straight. (See Lens.)

Aponeurosis (ap-on-u-ro'-sis). The fibrinous expansion of a tendon.

Apparent Position. The position apparently occupied by an object seen through a refracting medium, as distinguished from its real position.

Appendages of the Eye are the orbits, the eyebrows, the eyelids, the conjunctiva, the lachrymal apparatus, the muscles, the aponeurosis, and vessels and nerves of the orbit.

Applanatio-corneae (ap-lan-a'-she-o-kor'-ne-e). A condition in which the cornea becomes flattened.

Aqueous Humor (a'-que-us hu'-mor). A transparent, watery fluid which fills the anterior and posterior chambers, the iris becoming the boundary line between the two chambers. If this humor is allowed to escape it will re-form again. Its index of refraction is 1.33.

Aqueocapsulitis (a'-kwo-caps-u-li'-tis). Serous inflammation of the iris.

Arc. Any part of a curved line.

Arcus senilis (ar'-kus sen'-il-es). White circle in cornea near sclerotic. Condition in aged.

Area of Critical Definition. That portion of an optical image within which the detail is clearly defined.

Argamblyopia (ar-gam-ble-o'-pe-ah). Amblyopia from non-use of eye.

Argyll-Robertson Pupil. A pupil that will not respond to light, but contracts in accommodation. Can be seen in locomotor-ataxia.

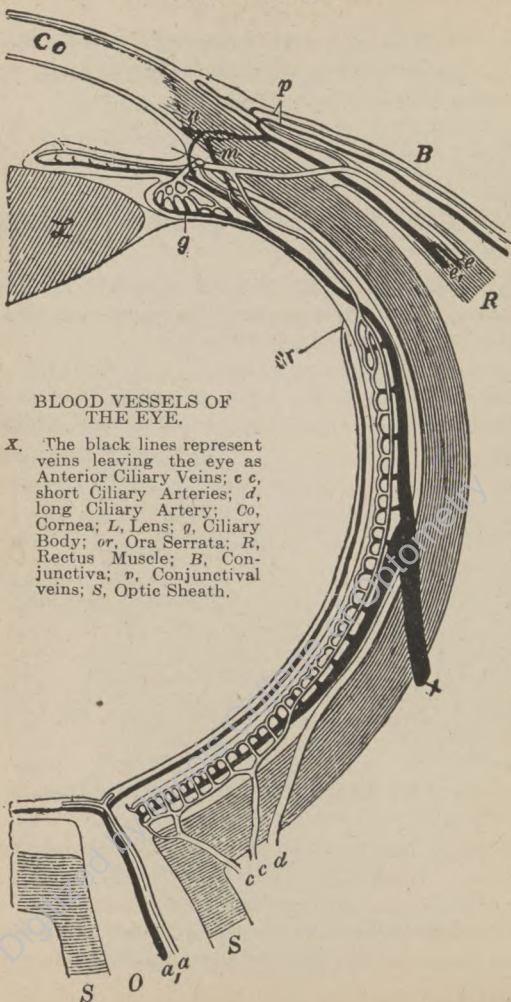
Artery. The vessel which carries the purified blood from the heart to the different cells of the body. The ophthalmic artery supplies the eye with blood.

Artificial Eye. A thin glass plate which resembles the sclerotic, cornea and iris. Artificial eyes are made in different sizes and colors, and are always fitted to match the sound eye. Before inserting the artificial eye it should be put into salt and water for a few minutes, then draw the upper lid out and down, and slip the eye up under; then draw the lower lid out and down, and in this way allow the eye to fall into position. As a rule, an artificial eye will last about a year, when it begins to lose its smoothness and a new one is required.

Asep'sis. Free from septic matter, or free from infection.

Asthenopia (as-then-o'-pi-ah). Weak and painful vision; subdivided into three kinds: retinal, muscular, and accommodative.

Retinal—where the eye cannot stand light without pain; intolerance of light; photophobia.



BLOOD VESSELS OF THE EYE.

- X. The black lines represent veins leaving the eye as Anterior Ciliary Veins; *c c*, short Ciliary Arteries; *d*, long Ciliary Artery; *Co*, Cornea; *L*, Lens; *q*, Ciliary Body; *or*, Ora Serrata; *R*, Rectus Muscle; *B*, Conjunctiva; *v*, Conjunctival veins; *S*, Optic Sheath.

Muscular—a condition of the eyes in which the muscles controlling their movement suffer from speedy fatigue, causing pain.

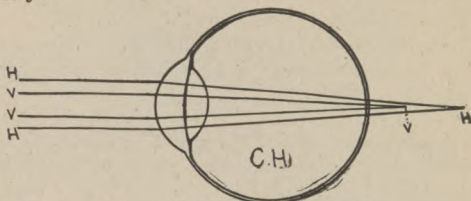
Accommodative—fatigue of the ciliary muscles by hypermetropia, presbyopia, or overwork in emmetropia.

Astigmatograph (as-tig'-ma-graf). An instrument used to demonstrate the state or condition of astigmatism of the eye.

Astigmatism (as-tig'-mat-ism). Astigmatism is a term applied to an eye whose refraction is not the same in all its parts, and it is subdivided into two kinds, REGULAR and IRREGULAR. Irregular astigmatism is where there is a difference of refraction in one and the same meridian, and according to Hartridge is subdivided into NORMAL and ABNORMAL. Normal irregular astigmatism is due in a great measure to irregularities in the refracting power of the different sectors of the lens, and causes a luminous point to appear stellate, or star shape. The abnormal variety is usually caused by ulcers, conical cornea, or injury of the cornea, but the same condition may be congenital. This kind of astigmatism cannot be corrected with lenses. Regular astigmatism is where we have the meridians of greatest and least curvature at right angles to each other, and are known as the principal meridians. This variety can be corrected with cylindrical lenses. It has five subdivisions, which merely serve to show the location of the focuses, which are as follows:

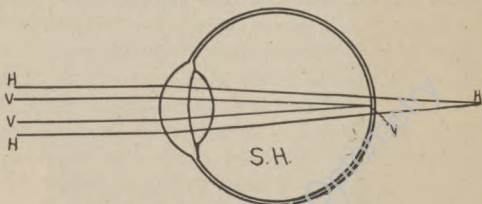
No. 1. COMPOUND HYPEROPIC ASTIGMATISM is that condition in which the foci of the two principal meridians are back of the retina at different

places when the eye is at rest and looking at infinity.



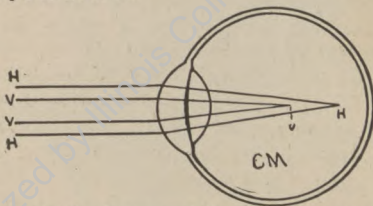
No. 1. Compound Hyperopic Astigmatism.

No. 2. SIMPLE HYPEROPIC ASTIGMATISM is that condition in which parallel rays enter the eye, and one of the principal meridians focuses



No. 2. Simple Hyperopic Astigmatism.

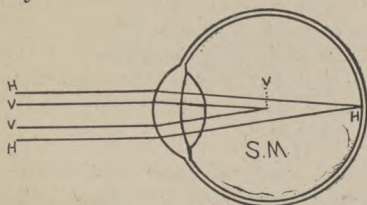
on the retina, the other behind the retina, when the eye is at rest.



No. 3. Compound Myopic Astigmatism.

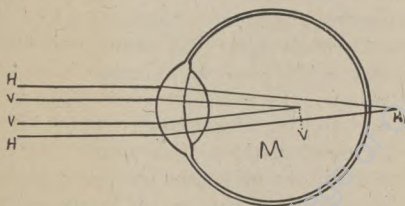
No. 3. COMPOUND MYOPIC ASTIGMATISM is that condition in which the two principal merid-

ians focus in front of the retina at different places when the eye is at rest and looking at infinity.



No. 4. Simple Myopic Astigmatism.

No. 4. SIMPLE MYOPIC ASTIGMATISM is that condition in which one of the principal meridians focuses on the retina and the other in front with the eye at rest and looking at infinity.



No. 5. Mixed Astigmatism.

No. 5. MIXED ASTIGMATISM is that condition in which one of the principal meridians focuses in front of the retina and the other behind the retina when the eye is at rest and looking at infinity. It derives its name, mixed astigmatism, from the fact that one meridian is hyperopic and the other myopic.

CORNEAL ASTIGMATISM is caused by irregularity of the curvature of the cornea.

LENTICULAR ASTIGMATISM is caused by an irregularity of the curvature of the crystalline lens.

ASTIGMATISM WITH THE RULE is where the axis of a minus cylinder that will correct the astigmatism is nearer the 180th meridian than the 90th, or the axis of a plus cylinder that will correct the astigmatism is nearer 90 than 180; otherwise, it is against the rule.

Correcting cases of high astigmatism often proves unsatisfactory at the time. When the image is formed on the retina of such an eye it is much blurred at one of the principal meridians, and sometimes distorted. However, the patient accepts this, as his vision has never been better. So much so that when the correct lenses form a distinct retinal image, he fails to recognize it, and will sometimes say that the object looks distorted, as the fibers of his optic nerve are somewhat amblyopic, and therefore different from those of other people. In such cases the brain is in the habit of accepting vision from parts of the retina that are most distinct, and when wearing their correction for the first time, the vision shows very little improvement, if any. It is not uncommon for cases, of say 4-D., of astigmatism to see very little better with their glasses at the time of fitting, but if they are worn persistently the vision is expected to improve in a few months.

Astringent (as-trin'-jent). An agent that causes contraction and arrests discharges.

Asymmetry (ah-sim'-et-re). When the eyes do not correspond, or resemble each other in appearance, they are said to lack symmetry.

Atrophy. A wasting away of a part from a lack of nutrition.

Atropine. A mydriatic which is used more than any other to suspend accommodation and dilate the pupil. Atropine paralyzes the sphincter muscle of the iris and the ciliary muscle, and hence results in dilatation of the pupil, and also in inability to see clearly near by. The dilatation of the pupil is a maximum one. If, in the case of a dilatation of the pupil caused by oculomotor paralysis, atropine is instilled, the pupil becomes still more dilated. This proves that atropine, besides producing paralysis of the contracting fibers, causes also stimulation of the dilating fibers. The effect of the atropine makes its appearance in from ten to fifteen minutes after the instillation, and soon reaches its maximum. Commencing with the third day it begins to decrease again, but does not disappear completely until after the lapse of a week. The instillation of atropine, therefore, causes the patient a disturbance of rather long duration, and hence should be employed only when there is good reason for it.

Atropinism (at'-ro-pin-ism). A condition produced by the use of atropine.

Atropinize. To put under the influence of atropine.

Autophthalmoscope (au-tof-thal'-mo-skope). An ophthalmoscope planned in such a way that a person can examine his own eyes.

Axial. Of, or pertaining to, an axis.

Axially. In the direction of the axis.

Axis. Straight line through a center, on which the body is supposed to revolve. The eye has two principal axes, the optic and visual. The optic axis is an imaginary line through the center of the cornea, through the nodal points to the inner side of the macula lutea. The visual axis is a line from the center of the macula lutea, through the nodal point to the object looked at. When speaking of the axis of a cylinder we mean the meridian of a cylindrical lens having no power. When parallel rays fall on the spherical surface of a lens, the ray which strikes the optical center at right angles will pass through unrefracted, and is known as the principal axis.

Axis of Refraction. The normal to the surface of a refracting medium at the point of incidence of a ray of light.

Axonometer (ax-o-nom'-e-ter). Apparatus for rapidly determining the axis of a cylindrical lens.

Bacillar Layer (bas'-il-ar). The layer of rods and cones of the retina.

Barometer. An instrument indicating the atmospheric pressure.

Basalis Lamina. Or membrane of Bruch. The membrane which separates the choroid from the pigmentary layer of the retina.

Base. Foundation or thick end of a prism.

Beer's Knife. A knife with a triangular blade for corneal incision.

Bi. Is employed to signify two things in one; for instance, bifocal, biconcave, biconvex.

Biconcave. Concave on both sides.

Biconvex. Convex on both sides.

Bifocal. Double focus. There are six kinds, namely:

No. 1. Solid bifocal.

No. 2. Split or Franklin bifocal.

No. 3. Perfection bifocal.

No. 4. Cemented bifocal.

No. 5. Invisible bifocal.

No. 6. Depressed bifocal.

The solid bifocal is now out of date. The split or Franklin bifocal must be worn in rims, while the depressed, invisible, and cemented can be mounted without rims, but cannot be worn near intense heat. A bifocal lens consists of two parts of two different foci. In presbyopia, or old sight, the upper is the weaker for distance, the lower being stronger for near objects. In myopia, the upper should be the stronger and the lower the weaker glass. In this way the patient has good distant vision without the extra strain on the accommodation.

Canada Balsam is used in cementing Bifocal Lenses in the following manner: First be sure that the lenses are PERFECTLY CLEAN. Then squeeze a small drop of the balsam onto the large lens, and press the scale upon the balsam until it spreads out thoroughly between the glasses, being careful not to break the lenses. Then place the lenses on a piece of metal over a small flame, and heat them slowly until all the bubbles disappear, and until the balsam is

nearly hard—just about hard enough to take a slight impression of the finger nail. It is impossible for a novice to accurately judge just how much to heat the lenses, but with practice it becomes a simple matter. The success depends largely on their being heated just long enough. If they are not heated enough they will slide out of position, and if they are heated too much they will chip off very easily.

Binocular. Pertaining to both eyes. In vision it refers to the ability of both eyes to see the same point of an object at the same time.

Biorbital Angle. The same as the optic angle.

Birefractive. Doubly refractive.

Blair-eye. Marginal blepharitis.

Blennorrhea (blen-or-e'-ah). Excessive mucous discharge.

Blepharadenitis (blef-ar-ad-en-i'-tis). Inflammation of the meibomian glands.

Blepharal (blef'-ar-al). Pertaining to the eyelids.

Blepharelosis (blef-ar-el-o'-sis). Ingrowing eyelashes. (See Trichiasis.)

Blepharism (blef'-ar-ism). Where there is an inability on the part of the patient to refrain from winking. (Blinking.)

Blepharitis (blef-ar-i'-tis). Inflammation of the eyelids. **Ciliaris b.** That condition where the hair follicles of the eyelids are inflamed.

- Blepharoplegia** (blef-ar-o-ple'-ge-ia). That state in which the eyelid is paralyzed, causing ptosis.
- Blepharoptosis** (blef-ar-op-to'-sis). That condition where the upper eyelid droops from paralysis.
- Blepharospasm** (blef'-ar-o-spasm). That condition in which there is a spasm of the orbicular muscle of the eyelids.
- Blepharostat** (blef-ar'-o-stat). An instrument used for holding the eyelids apart.
- Blepharostenosis** (blef-ar-o-ste-no'-sis). A narrowing of the palpebral slit between the eyelids.
- Blepharosynechia** (blef-ar-o-sin-ek'-i-a). A condition in which there is a growing together of the eyelids.
- Blepharotomy** (blef-ar-ot'-o-me). A surgical operation for the cutting of the eyelid.
- Blind.** Loss of sight. Day-blindness is where vision is better at night. Night-blindness is defective vision at night-time.
- Blind Spot.** Also known as the optic disc, or papilla. It is the entrance of the optic nerve on the retina.
- Blinking.** That condition in which there is an involuntary winking.
- Bonnet's Capsule.** The same as Tenon's Capsule.
- Bowman's Membrane.** The second anterior layer of the cornea.

Brachymetropia (brach-e-me-tro'-pe-a). The same as myopia and hypometropia. It is an eye where parallel rays of light will focus in front of the retina with the muscles of accommodation at rest.

Brain. A nervous mass within the skull.

Buphthalmia (buf-thal'-meh-ah). Enlargement of the eye.

Buphthalmus. (See Buphthalmia.)

Campimeter (kam-pim'-e-ter). An instrument for measuring the field of vision.

Canada Balsam. A product obtained from a tree that grows in Canada, and is used for the purpose of cementing lenses. It is easily melted if heated, and readily soluble in alcohol.

Canals of Fontana. A number of little spaces or openings between the iris and cornea, in the sclerotic. (See Anatomy.)

Canal of Petit. The space which surrounds the crystalline lens between the suspensory ligaments.

Canal of Schlemm. Circular canal surrounding the eye at sclerocorneal junction. (See Anatomy.)

Canal of Stilling. The canal which runs through the vitreous humor from the entrance of the optic nerve to the posterior surface of the lens. It is lined by the hyaloid membrane. This canal is said to convey the minute artery from the central artery of the retina to the back of the lens, during development of the eye. The artery then disappears, but the canal remains.

Canthectomy (kan-thek'-to-my). An operation in which part of the canthus is cut away.

Canthitis (kan-thi'-tis). Inflammation of the angles of the eyelids.

Canthoplasty (kan'-tho-plas-te). A surgical operation for lessening the pressure and friction of the upper lid by cutting the outer canthus. **Plastic c.** operation, an operation for restoring a lost part.

Canthotomy (kan-thot'-o-me). An operation for the slitting of either canthus.

Can'thus. The angle at the junction of the eyelids, known as the inner and outer canthi.

Capsule (kap'-sule). A sac which encloses an organ for the purpose of support, protection, and lubrication.

Capsule of Tenon. (See Tenon's Capsule.)

Capsulitis (kap-su-li'-tis). Inflammation of the capsule of the crystalline lens.

Capsulotomy (kap-su-lot'-o-my). An operation for the cutting of a capsule, as that of the lens.

Cardinal Points. (See Nodal Point.) *

Cartilage (kar-'til-aj). The gristle or white elastic substance in different parts of the body.

Caruncula Lachrymalis (kar-un'-ku-lah). Is the small reddish body at the inner canthus of the eye.

Cast. A cast in the eye would apply to strabismus, or squint.

Cataphoria (kat-af-o'-re-ah). A tending of one eye downward. If it is the right eye it is right cataphoria, and if it is the left eye it is left cataphoria. **Esocatophoria** is the tendency of the visual line inward and downward. **Exocatophoria** is the tendency of the visual line outward and downward.

Cataract (kat'-ar-akt). Any opacity of the crystalline lens or lens capsule of the eye. **Lenticular c.**, an opacity of the lens proper. **Capsular c.**, an opacity of the lens capsule. **Senile c.**, an opacity of the lens due to age. **Traumatic c.**, a cataract due to an injury. **Pyramidal c.**, an opacity in the center, yet at the anterior pole, of the lens. **Secondary c.**, a cataract appearing after the extraction of the lens, caused by that part of the lens capsule still attached to the hyaloid membrane becoming opaque. **Cortical c.**, that condition in which the border or outer layers of the lens are losing their transparency. **Hard c.** (see Senile c.). **Soft c.**, where the lens is soft and milky. **Polar c.**, an opacity confined to the anterior or posterior pole of the lens.

Catop'trics. Laws of reflection of light.

Catoptric Test (kat-op'-trik). A test for cataract by light reflected from the crystalline lens. In this test ask the patient to look straight ahead, then hold a lighted candle about twelve inches in front of the eye, a little to one side, while you stand slightly on the other and look into his pupil. If there is no opacity of the lens or capsule you will notice three images of the candle. The first will be on the surface of the cornea in an upright position, the second will be on the an-

terior surface of the lens, also upright, while the third will be inverted and much smaller on the posterior surface of the lens, but when there is a cataract you will fail to find the inverted image.

Cat's-eye Pupil. Where the pupil of the eye is long and narrow (slit-like).

Center (of Curvature). If the surface of a lens were completed so as to form a circle, its center would be the center of curvature. (For Optical Center see appendix).

Centimeter (sen'-tim-e-ter). One-hundredth part of a meter.

Centrad (sen'-trad). Toward the center; unit of measurement for prisms which will produce a deviation in a ray of light one-hundredth of a radian.

Centric (sen'-trik). Pertaining to a nerve center.

Ceratitis (ser-at-i'-tis). The same as keratitis.

Ceratonosus (ser-at-on'-o-sus). Any disease of the cornea.

Ceratome (se-rat'-o-tom). A knife for dividing the cornea.

Chalazion (chal-a'-zi-on). A tumor on the eyelid. On the under surface of the tarsal plate of the upper and lower lid are numerous creases or depressions running at right angles to the margin of the lid. There are about thirty of them in the upper lid and about twenty in the lower. In these depressions are small tubular glands, called meibomian glands, and their ducts open next to

the margin of the lid. A chalazion is an enlargement of one or more of these glands, due to the stoppage of their ducts, and is usually chronic in character. A chalazion is also called a tarsal tumor, tarsal cyst, or meibomian cyst, etc. It is not a true retention cyst, but its contents may soften so that it will become an encysted abscess. At first its contents are gelatinous, but later may become purulent. The tumor is firm, round, with the skin moving freely over the mass, but it is firmly attached to the tarsal plate. It has so much the appearance of a sebaceous cyst that one is liable to be mistaken in the diagnosis, unless he is familiar with the disease. Usually chalazion tends toward the conjunctiva, and, if the lid is everted, the position of the tumor may be located by a bluish discoloration, or, if the contents are purulent, a yellowish discoloration. The primary cause of this trouble is not definitely known, but a debilitated condition of the system, eye-strain, and blepharitis marginalis seem to be the factors in producing chalazion.

Chambers. The spaces of the eye. **Anterior c.**, the space between the cornea and the iris. **Posterior c.**, the space between the iris and the lens.

Check Ligament. A few fibers attached by one end to the anterior wall of the orbit and by the other to the tendons of the recti muscles. Those on the inner side are called the internal check ligaments, and those on the outer or temple side the external check ligaments. The action of these ligaments is a normal one. They probably prevent or retard over-action of the abductors or adductors.

Chemosis (ke-mo'-sis). Edema of the conjunctiva of the eye.

Chiasm (ki'-asm). A crossing; especially the crossing of the fibers of the optic nerve (optic commissure).

Chiastometer (ki-as-tom'-e-ter). An instrument for ascertaining the deviation of the optic axis.

Chlorophane (klo'-ro-fan). A green-yellow pigment from the retina.

Choked Disc. Congested and inflamed state of the optic disc.

Chondral (kon'-dral). Pertaining to cartilage.

Choroid (ko'-roid). A part of the second tunic. (See Tunic.)

Choroidal Fissure. The opening in the choroid through which the optic nerve passes to form the retina.

Choroideremia (ko-roi-de-re'-me-ah). Absence of the choroid.

Choroiditis (ko-roi-di'-tis). Inflammation of the choroid.

Choroidocyclitis. Inflammation of the choroid and ciliary processes.

Choroidoiritis (ko-roi-do-i-ri'-tis). Inflammation of the choroid and iris.

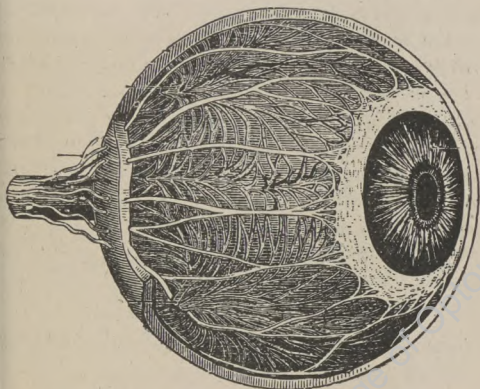
Choroidoretinitis. Inflammation of the choroid and retina.

- Chromatic** (kro-mat'-ik). Relating to color.
- Chromatic Aberration.** (See Aberration.)
- Chromatodysopia** (kro-mat-o-dys-o'-pi-ah). Color-blindness.
- Chromatology** (kro-mat-ol'-o-gy). The study of colors.
- Chromatom'eter.** An instrument for measuring color or color perception.
- Chromatophobia** (kro-mat-o-fo'-be-ah). An abnormal fear of color.
- Chromatopsia** (kro-mat-op'-se-ah). Abnormal sensation of color, due to disorders of the optic centers, or to drugs, especially santonin.
- Chromatoptometry** (kro-mat-op-tom'-et-ry). Taking the measurement of the power of color perception.
- Chromometer** (kro-mom'-et-er). An instrument for measuring coloring matter present.
- Chromoptometer** (kro-mop-tom'-et-er). An instrument to test the color sense.
- Cibisitome** (sib-is'-it-om). An instrument for incising the lens capsule.
- Cilia.** The eyelashes. Hair.
- Ciliariscope** (sil-i-ar'-is-cope). An instrument for examining the ciliary region of the eye.
- Ciliary** (sil'-i-a-ry). Pertaining to, or like, the eyelashes.

Ciliary Body. The middle part of the second tunic, composed of ciliary processes, ciliary veins, ciliary muscles, ciliary nerves and arteries.

Cillo (cil'-lo) or **Ciliosis.** A trembling or spasmodic twitch of the eyelids.

Cinerea (sin-e'-re-ah). The gray matter of the nervous system.



Cut showing Choroid Ciliary Muscle and Nerves.

Circles of Haller. Venous and arterial circles of the eye.

Circulation (cir-cu-la'-shun). The passage of blood in going from and returning to the heart after having made a circuit of the body.

Clonic Spasm. An intermittent involuntary contraction of the ciliary muscles, which shows itself when the eye is in use.

Cocain (ko-ka'-in). A local anesthetic and mydriatic. Cocain dilates the pupil, and hence would seem to call for mention in this place, although, strictly speaking, it does not belong to the mydriatics proper—that is, the dilatation of the pupil by cocain is not produced, as in their case, by its action upon the contracting or the dilating fibers of the iris, but by a contraction of the blood-vessels of the iris. The dilatation of the pupil is therefore only a moderate one, and the reaction of the pupil to light persists; moreover, mydriatics and miotics still produce an effect. If cocain is instilled into an eye the pupil of which has been dilated by atropine, the dilatation increases somewhat in consequence of the anaemia of the iris which then ensues; hence the mydriasis produced by the simultaneous action of atropine and cocain is the most complete that can possibly be attained. The accommodation is not paralyzed by cocain, but only somewhat weakened.

Collyrium (col-lyr'-i-um). Any lotion to be dropped in the eye.

Coloboma (kol-o-bo'-mah). A tear or break in the eyeball, as in the iris or choroid.

Color-Blindness (*Achromatopsia*). Blindness for one or more colors. Due to the absence from the retina of one or two of the three primary substances (according to Hering). The test is made by presenting the patient with samples of different colored yarns—a number of each color, but different shades—and the patient is requested to separate them. Persons having this anomaly of vision are generally unaware of it themselves.

Commissure (kom'-mis-ur) (**Optic**). The crossing of the two optic nerves.

Compound. A lens that contains a sphere and a cylinder.

Comus (ko'-mus). A cone. A crescentic patch of atrophic choroid tissue near the optic papilla in myopia.

Concave. The negative of convex.

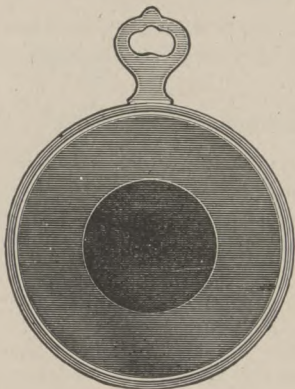
Concavo-convex. Concave on one side and convex on the other. If the convexity exceeds the concavity it is known as a periscopic convex lens. If the concavity exceeds the convexity it is known as a periscopic concave lens.

Concentric. Having a common center.

Concomitant (kon-com'-it-ant). Accompanying. Concomitant Squint is a condition where the two eyes deviate, but accompany one another in their movement. The object can be seen by either eye, but not the two eyes at the same time.

Cone Muscle Test. This consists of a cone cemented to a ground glass disc, and is used as follows: It is inserted into one cell of trial frame in front of the correction for the ametropia, which must be properly centered as to pupillary distance, and a solid blank disk is put into the cell in front of the other eye. The patient's attention is then directed to a light (preferably a candle or small gas light) twenty feet away; and the action of the cone is such that the light will resolve itself into a circle of light. The other eye is then uncovered, and if there is no muscular error the light will appear in the center of the circle. If there is mus-

cular error the light will be either above or below or to one side of center, and can be brought to center by the proper prism with base in proper position. This does away with necessity for com-



Cone.

putations where there is combined prismatic error in different angles, and gives at once the position of the base of the correcting prism. (See Muscular Imbalance.)

Conical Cornea. A condition of the cornea in which it bulges forward in the shape of a cone.

Conjugate (coupled).

Conjugate Foci (kon'-ju-gat). Two points so situated in relation to each other that the direction of a ray proceeding from either of them, after reflection or refraction, passes through the other.

Secondary C.—A conjugate foci formed on a secondary axis.

Conjunctiva (kon-junc-ti'-va). The mucous membrane lining the eyelids and anterior covering of the cornea, and is supplied by a branch of the fifth sensory nerve (ophthalmic).

Conjunctivitis (kon-junc-tiv-i'-tis). Inflammation of the conjunctiva.

Convergence (kon-ver'-gence). The power of turning the two eyes to a given point inside of infinity. In the emmetropic eyes of a healthy person, the two functions of accommodation and convergence work together so that they can scarcely be performed separately. Yet their objects are totally different, but their harmonious co-operation is none the less essential. The function of accommodation has for its purpose the formation of a clearly defined image on the retina of each eye singly; while the function of convergence is the fusing of the two retinal images into a single sensory perception; that is to say, the turning of the two eyes inward so that the image will fall on corresponding parts of each retina; but an object at a given distance will always require from the same pair of eyes the same amount of accommodation, and it will also require from them the same amount of convergence. Say the object is at thirteen inches, where it will require three diopeters of accommodation, then it will also require three meter angles of convergence; that is to say, convergence to such a degree that the lines of direction of the two eyes would intersect at a point thirteen inches from them; and further, that if the object was brought nearer, the accommodation and convergence would increase to an equal extent. When one's eyes accommodate

more than they converge, in order to see at a single point, they are hyperopic to the extent of the difference between the two functions; and when they converge more than they accommodate for a given point, they are myopic the difference. This of course refers to errors of refraction.

Convergent. Turning toward the same point.

Convex. That which has a rounded and elevated surface. The surface, if continued at the same radius of curvature, would form a complete circle, or sphere.

Convexo-concave. Convex on one side and concave on the other. If the convexity exceeds the concavity it is known as a periscopic convex lens. If the concavity exceeds the convexity it is known as a periscopic concave lens.

Copiopia (kop-i-o'-pi-ah). A worn-out state of the eye, caused by eye strain.

Coreclisis (kor-ek'-lis-is). That condition in which the pupil of the eye is obliterated.

Corectasis (kor-ek'-tas-is.) Dilatation of the pupil.

Corectome (kor-ec'-to-me). An instrument used in cutting for iridectomy.

Corectopia (kor-ec-to'-pi-ah). That condition in which the pupil is displaced.

Coredialysis (kor-e-di-al'-ys-is). An operation in which the iris is detached from the ciliary ligament for a new pupil.

Corelysis (kor-el'-ys-is). Detachment of adhesions of the iris to the cornea or the lens capsule.

Coremorphosis (kor-e-mor'-pho-sis). Creation of an artificial pupil.

Coreometer (kor-e-om'-et-er). A contrivance used for measuring the pupil.

Cornea (kor'-ne-ah). The anterior and transparent part of the eyeball. It has no blood-vessels, but plenty of nerves and lymphatics. It serves to transmit light into the eye. It is convex in front and concave behind. Its curvature varies in different individuals. It is composed of five layers, arranged as follows, from without inward: namely, (1) Conjunctiva epithelium; (2) Bowman's Membrane; (3) Cornea proper; (4) Membrane Descemet; (5) Endothelium. The third layer (cornea proper) is the foundation layer of the cornea. It is composed of a horn-like substance and is non-sensitive and merely serves to keep the cornea in shape. The second layer (Bowman's Membrane) is a layer of sensitive nerves and elastic tissue, and protects the cornea proper on the anterior side, and at the same time gives the cornea an elastic nature. The first layer (Conjunctiva epithelium) serves to protect the nerves in Bowman's Membrane from cold, wind, and dust, and at the same time gives a highly polished surface to the cornea. The fourth layer (Membrane Descemet) is a layer similar to Bowman's Membrane, and protects the cornea proper from any diseased condition from the posterior side. The fifth layer (Endothelium) is a lining membrane which separates the aqueous humor from the fourth layer, and at the same time forms a sort of sac which contains the aqueous humor. The cornea has an index of refraction of 1.33. Its nerve supply arises from the ciliary nerves.

Cor'neal. Pertaining to the cornea.

Corneal Astigmatism. (See Astigmatism.)

Corneal Facets (fas'ets). Small, plain distinct surfaces of the cornea.

Corneitis (cor-ne-i'-tis). Inflammation of the cornea.

Corneo-iritis. Inflammation of the iris and cornea.

Correction. Making good an abnormal condition, such as correcting an error of refraction.

Cortical (kor'-tik-al). To be near the border.

Cortical cataract is that variety in which the opacity begins at the border of the crystalline lens and gradually spreads toward the center, which it sooner or later involves.

Couching. That condition in which the lens is displaced in cataract. This operation is now obsolete.

Cover Test. A test for muscular imbalance by covering one eye and observing its movements while uncovering; the point of fixation being established.

Cramp. A spasmodic muscular contraction.

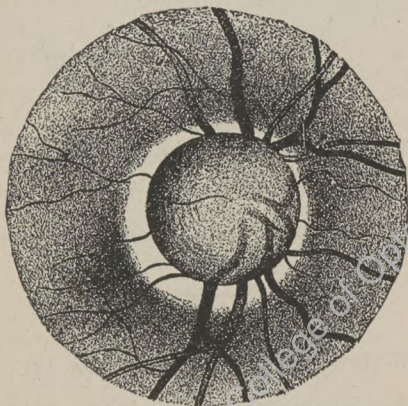
Cribriform (krib'-rif-orm). Perforated like a sieve.

Critical Angle (krit'-ik-al). The least angle of incidence at which a ray of light traveling in a denser medium is totally reflected at the surface which separates it from a rarer medium; also known as limit angle.

Crossed Diplopia. (See Diplopia.)

Crystalline Lens (krys'-tal-een). The lens of the eye which resembles a crystal, located behind the iris, and is made up of layers like an onion, which give it an elastic nature. The lens itself is enclosed in the lens capsule, which is held in its position by the suspensory ligaments. Its index of refraction is 1.43. The lens of the eye represents from 19 to 20D. of plus when at rest.

Cryptometer. (See Curtometer.)



Cupped Disc.

Cupped Disc. That condition in which the optic disc has become cupped, as seen in glaucoma.

Curtom'eter. An instrument for measuring curved surfaces.

Curvature (curv'-a-ture). The bending of a line without forming angles.

- ✓ **Cyclitis** (eye-li'-tis). Inflammation of the ciliary body.
- Cyclochoroidi'tis**. Inflammation of the choroid and ciliary body.
- ✓ **Cyclophoria** (cyc-lo-fo'-ri-ah). That condition in which the vertical axis of the eye inclines to the right or left instead of standing vertically, the extrinsic muscles being at rest.
- Cyclopia** (si-klo'-pe-ah). A single eye in center of forehead.
- Cycloplegia** (cy-clo-ple'-gi-ah). Paralysis of the ciliary muscles.
- Cycloplegic**. A drug which produces paralysis of the ciliary muscles, or muscles of accommodation.
- Cylinder** (cyl'-in-der). (See Lens.)
- Cystitome** (sis'-tit-om). An instrument used for opening the sac of the crystalline lens.
-

D. Abbreviation for diopter, dexter, or dose.

Dacryadenalgia (dak-ry-ad-en-al'-gi-ah). Pain in a lacrimal gland.

Dacryagogue (dak'-ry-ag-og). A medicine which causes a flow of tears.

Dacryoadenitis (dak-ry-o-ad-en-i'-tis). Inflammation of a lacrimal gland.

Dacryoceale (dak'-ry-o-cele). A cyst of the lacrimal sac.

Dacryocyst (dak'-ry-o-cyst). The tear sac.

Dacryocystalgia (dak-ry-o-cyst-al'-gi-ah). Pain in the lacrimal sac.

Dacryocystitis (dak-ry-o-cys-ti'-tis). Inflammation of the lacrimal sac.

Dacryoma (dak-ry-o'-ma). A lacrimal tumor which causes an obstruction of the lacrimal puncta, so that the tears flow over the lids upon the cheek.

Dacryon (dak'-re-on). The lacrimal point; a place where the lacrimal, frontal, and upper maxillary bones meet.

Dacryops (dak'-re-ops). That condition in which there is distention of a lacrimal duct.

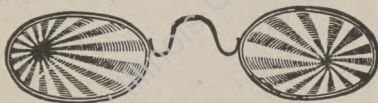
Dacryorrhea. Excessive or morbid flow of tears.

Daltonism (dawl'-ton-izm). Color-blindness.

Day-blindness (day-blind'-ness). Partially blind by day, with better vision at night.

Decameter (dek'-a-me-ter). Ten meters.

Decentered (de-cen'-terd) **Lens**. A lens with its optical center to one side or above or below the center.



Decentered Lenses.

Decentering of Lenses. Instead of having a prism and a lens combined where you wish to obtain the effect of both, it is possible to get the same result by simply decentering the optical center of the

lens. The optical center of a plus lens is at its thickest part, and in the minus at its thinnest part, while the geometrical center of a lens is the point midway between all edges. A 1-diopter lens decentered 9.4 millimetres will give the effect of a 1-degree prism, while a 2-D. lens will only require to be decentered half this amount, or 4.7 millimetres; a 3-D. lens, one-third of this amount, or 3.1+ mm. for the same effect, and so on according to the strength of the lens. To obtain the effect of a 2-degree prism these lenses must be decentered twice as much, that is to say, a 1-D. lens, 18.8 mm.; a 2-D. lens, 9.4 mm.; a 3-D., 6.3 mm. From this table one can easily figure the exact amount any lens should be decentered to obtain a given prismatic effect.

Decentration (de-cen-tra'-tion). The act of removing from a center.

Decimeter (des'-im-e-ter). One-tenth of a meter.

Defect (de-fect'). A departure from the normal. When speaking of defects of vision we mean the visual power of the eye is not normal.

Defining Power, Definition. The power of a lens to give a clear outline.

Depilation (dep-il-a'-shun). The removal or loss of the hair.

Deplumation (de-plu-ma'-shun). Loss of eyelashes by disease.

Deprimens Oculi (dep'-ri-mens ok'-u-li). The rectus inferior muscle.

Descemet's Membrane (des-ce-mets' mem'-brane).
The fourth layer of the cornea. (See Cornea.)

Descemetitis (des-em-e-ti'-tis). Inflammation of
Descemet's Membrane.

Deviation (de-vi-a'-shun). Turning aside, as in strabismus. **Conjugate d.**, deviation of both eyes to the same side. **Minimum d.**, the smallest deviation of a ray that a given prism can produce.

Dexter, Dextra (dex'-ter, dex'-tra). On right side.

Dextrad (dex'-trad). Toward the right side.

Diameter (di-am'-e-ter). A straight line joining opposite points of a circle.

Diaphaneity (di-af-a-ne'-i-ty). Transparency; the power of transmitting light.

Diaphanous (di-af'-a-nous). Having power to transmit rays of light, as glass.

Diaphragm (di'-af-ram). A term applied to the partition with a central aperture in optical instruments so that rays of light may be controlled. The iris with its pupil constitutes the diaphragm of the eye.

Diapysis (di-ap-i-e'-sis). Suppuration.

Diffraction (dif-frak'-shun). Deflection or decomposition of light in passing by the edges of opaque bodies or through small apertures.

Diffusion (dif-fu'-shun). A spreading or scattering of rays of light, causing a blurred image by imperfect refraction.

Dilatant. A medicine that causes dilatation.

Dilatation (di-la-ta'-shun). The expansion of any orifice or canal.

Dilator (di-la'-tor). Dilator iris refers to the radiating fiber of the iris which dilates the pupil.

Dioptr (di-op'-ter). A lens of one meter focus is taken as the unit from the metric system, and is called a diopter. A lens of two diopters is twice the strength of the former, and has a focal length of half a meter. Synonyms, Dioptre and Dioptry.

Dioptrimeter (di-op-tom'-e-ter). An instrument for testing ocular refraction.

Dioptrometry (di-op-tom'-e-tre). The measurement of ocular accommodation and refraction.

Dioptral (di-op'-tral). Pertaining to a diopter.

Dioptries (di-op'-trijs). Pertaining to refracted light.

Dioptry (di-op'-tre). (See Diopter.)

Diplocoria (dip-lo-ko'-re-ah). Double pupil.

Diplopia (dip-lo'-pe-ah). Double vision. The object of convergence is to direct the yellow spot (or macula lutea) in each eye toward the same point, so as to obtain single vision; diplopia, or double vision, at once resulting when the image of an object falls on parts of the retina which do not exactly correspond in the two eyes. **Heteronymous d.**, where the object seen with the right eye appears on the left side, and that of the left eye on the right side. **Homonymous d.**, where the object of the right eye appears on the right side, and the object of the left eye on the left side. **Monocular d.**, diplopia with a single eye.

Diplopiometer (dip-lo-pi-om'-e-ter). An instrument for measuring diplopia.

Disc (disk). A round body which resembles a small circular plate. **Optic d.**, a whitish circular spot in the retina representing the entrance of the optic nerve into the globe of the eye.

Discission (dis-ish'-un). The rupture of the capsule of the crystalline lens in the operation for soft cataract.

Diseases of the Eye. The diseases of the eye are many, but nearly all of them can be directly or indirectly attributed to eye strain or impurity of the blood. First, relieve any eye strain by glasses. Second, keep the bowels regular. Third, fresh air and exercise. When the patient requires further attention, proper treatment should be instituted.

Disparate Points (dis'-par-at). Points on the two retinæ upon which light does not produce the same impression.

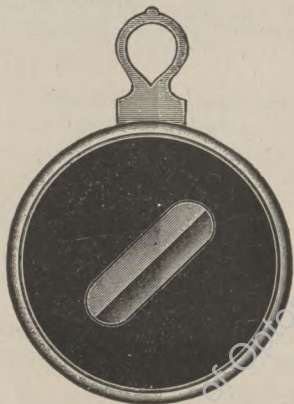
Dispersing Lens (dis-per'-sing). Same as concave lens.

Dispersion (dis-per'-shun). The process of scattering the rays of light through any kind of a lens.

Distichiasis, Distichia (dis-te-ki'-a-sis, dis-tik'-e-ah). That condition of the eyelashes in which a second row rubs against the cornea, causing inflammation.

Divergence (di-ver'-gens). To turn outward from parallelism.

Donders (Frans Cornelis). A Dutch physician, born at Tilburg, Holland, May 27, 1818. He was educated at Utrecht, where he became a professor of physiology, histology, and ophthalmology in 1847. Among his works are, "A Study of the Movements of the Eyes," "Astigmatism," "Anomalies of Refraction and Accommodation." He died March 27, 1889.



Double Prism.

Double Prism. An opaque disc with a slit-like opening. Over this slit there are two prisms with their bases together. Used for testing for muscular imbalance.

Double Vision. Seeing two images instead of one. (See Diplopia.)

Doublet (doub'-let). Composed of two lenses.

Dynamic Refraction (dy-nam'-ic). The refraction of the eye when adjusted for the near point. The difference between the dynamic and static refraction is known as the Amplitude of Accommodation

Eccentric (ek-sen'-trik). Away from a center.

Ecchymosis. An extravasation of blood into tissue.

Ectasia (ek-ta'-se-ah). Abnormal distention or dilatation of a part.

Ectiris (ek-ti'-ris). The external portion of the iris.

Ectochoroidea (ek-to-cho-roi'-de-ah). The outer layer of the choroid coat.

Ectocornea (ek-to-kor'-ne-ah). Outer layer of the cornea.

Ectoretina (ek-to-ret'-in-ah). Outermost layer of the retina.

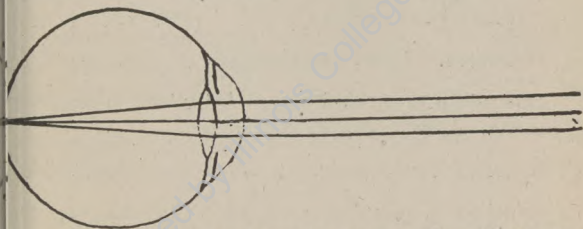
Ectropion (ek-tro'-pi-on) **Ectropium**. Turning out or inside out of the edge of an eyelid.

Em'bolism. Obstruction of a vessel by an embolus.

Em'bolus. A clot or plug which obstructs a blood-vessel.

Emergent. A ray of light after having passed through a refracting medium.

Emissive. Radiating.



An emmetropic eye receiving one set of parallel rays. It must be remembered that the three rays representing the set come from one point, but the point is so far away that the rays appear to be parallel because the divergence is so slight.

Emmetropia (em-met-ro'-pi-ah). An eye where parallel rays of light will focus on the retina with the muscles of accommodation at rest. (Cut, p. 57.)

Encan'this. A minute tumor in the inner canthus of the eye.

Enophthalmus (en-of-thal'-mus). A condition where the eyes are deep-seated.

Entrophe (en'-stro-fe). A turning inward.

En'tad. Toward a center.

Entochoroidea (en-to-cho-roi'-de-ah). The inner layer of the choroid.

Entocornea (en-to-cor'-ne-ah). Descemet's Membrane.

Entoptic (en-top'-tic). Situated within the eye.

Entoptoscopy (en-top-tos'-co-py). Inspection of the interior of the eye.

Entoretina (en-to-ret'-in-ah). The nervous or inner layer of the retina.

Entropion. (See Entropium.)

Entropium (en-tro'-pi-um). A turning in or inversion of the eyelid or eyelashes.

Enucleate (e-nu'-cle-ate). To remove from its cover.

Enucleation (e-nu'-cle-a'-shun). Operation for the removal of the eye.

Epicanthus (ep-i-can'-thus). A fold of skin projected over the inner canthus.

Epiphora (e-pif'-or-a). An overflow of tears, causing them to run down the cheek.

Episcleral (ep-i-scle'-ral). Situated over the sclera of the eye.

Episcleritis (ep-i-scle-ri'-tis). Inflammation of the outer layers of the sclera.

Equil'ibrating operation. Tenotomy of the muscle, which antagonizes a paralyzed muscle of the eye.

Errors of Refraction. Abnormal conditions of refraction in the eye.

Erythroopia (er-ith-rop'-se-ah). Red vision.

Eserine (es'-er-een). An alkaloid obtained from the calabar-bean, which will cause contraction of the pupil. It has an action exactly opposite to that of atropine, since it places the iris and ciliary muscle in a state of tonic contraction. Consequently, miosis develops so that the pupil is about the size of a pin's head, with adjustment of the eye for the near point, as if marked myopia were present. We generally apply sulphate of eserine in one per cent solution. This solution, when freshly prepared, is colorless, but after some days becomes red, although without losing its activity. The instillation of eserine produces, simultaneously with the changes in the iris, a feeling of great tension in the eye, and frequently headache and even nausea, so that with many persons it cannot be employed. For this reason, hydrochloride of pilocarpine, prescribed in a one to two per cent solution, is recommended as a miotic for ordinary use. Its solution keeps

better than that of eserine, and does not act as powerfully as the latter, but is not accompanied by any unpleasant complications. **Eserine** is best reserved for those cases in which pilocarpine is ineffectual.

Esophoria (es-o-fo'-ri-ah). A tendency of the eyes to deviate inward, usually caused by hyperopia.

Esotropia (e-so-tro'-pi-ah). This term expresses a stronger meaning than Esophoria, in which there is merely a tendency, while in Esotropia there is a positive and visible appearance of the eyes turning inward.

Excavation (ex-cav-a'-shun). Excavation of optic nerve; cupping or hollowing of the optic disc.

Exophoria (ex-o-fo'-ri-ah). A tendency of the eye to deviate outward.

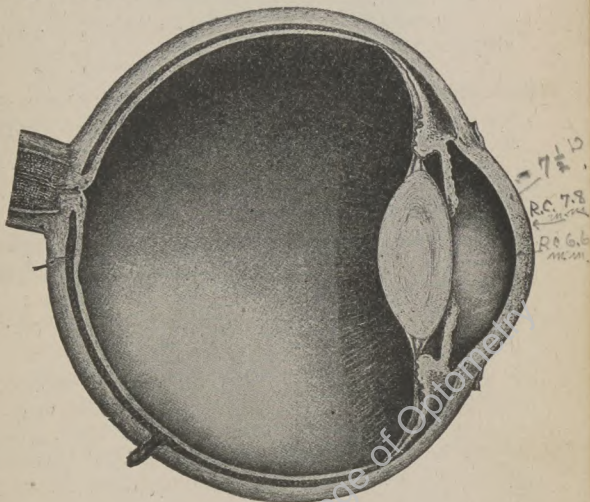
Exophthalmic Goiter (eks-off-thal'-mik goi'ter). A goiter with exophthalmos and cardiac palpitation; Basedow's disease; Graves' disease. The most prominent symptoms are protrusion of the eye, excited action of the heart, enlarged thyroid (goiter), and certain nervous phenomena. The protrusion is almost invariably bilateral, though not infrequently greater on the right side. The upper lids do not follow the eyeball in looking down (Von Graefe's sign); infrequency of involuntary winking (Stellwag's sign) and abnormal width of the palpebral aperture are also found.

Exophthalmos (ex-of-thal'-mos). Abnormal protrusion of the eye.

Exor'bitism. Protrusion of the eyeball.

Exotropia (ex-o-tro'-pi-ah). When the eye is turned outward from parallelism. Divergent strabismus.

Extraction (ex-trak'-shun). The removal of a body by surgical means.



Eye.

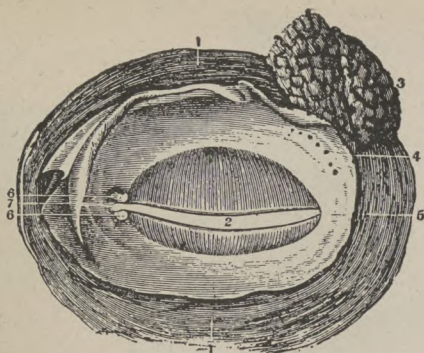
Eye. The organ of sight. The function of each eye, taken singly, is to form upon the retina, or nervous membrane which lines the inside and back part of the organ, a sharply defined inverted image of any object looked at. The eye resembles a photographer's camera, inasmuch as the image produced upon the retina is precisely the same as that produced on the ground glass of a camera. By means of the optic nerve the image that is received on the retina is conveyed to the brain,

which recognizes the visual appearances and completes the act of seeing. More than this we do not know, but we do know that it depends upon the sharpness and clearness of the retinal image. If the image is blurred and indistinct it will be impossible for the brain to recognize the object accurately.

Eyebrows. They are two projecting arches of integument covered with short thick hairs, which form the upper boundaries of the orbits.

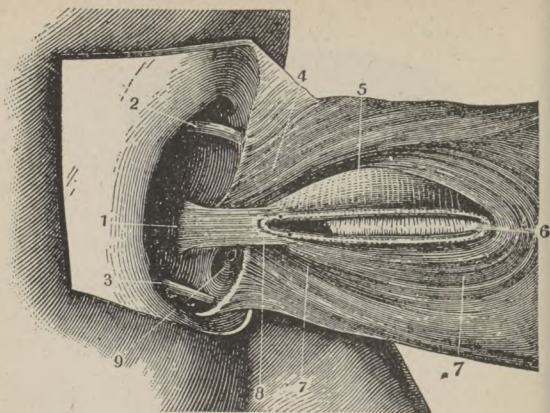
Eyelashes. The hair of the eyelids.

Eyelids. The anterior covering of the eye; that portion of movable skin with which the eyeball is covered or uncovered at will, protecting it from injury by their closure. The upper lid is the larger, the more movable of the two, and is supplied by a separate muscle, levator palpebrae superioris. When the eyelids are open an elliptical space is left between their margins, the extremities of which correspond to the junction of the upper and lower lids, and are called canthi. The outer canthus is more acute than the inner, and the lids here lie in close contact with the globe, but the inner canthus is prolonged for a short distance inward, toward the nose, and the two lids are separated by a triangular space, the lacus lachrymalis. At the commencement of the lacus lachrymalis and on the margin of each eyelid is a small conical elevation, the lachrymal papilla (the puncta), the apex of which is pierced by a small orifice, the commencement of the lachrymal canal. **Structures of the Eyelids.** The eyelids are composed of



Posterior View of Eyelid showing how the Tears enter the Conjunctiva.

1. Orbicularis Palpebrarum Muscle.
2. Opening between the lids (Palpebral Fissure).
3. Lachrymal Glands, where the tears have their origin.
4. Its ducts opening in the fold of the Conjunctiva.
5. Conjunctiva lining inside of lid.
6. Puncta Lacrimalia, through which the tears pass.
7. Inner Canthus.



**Posterior View of the Palpebral (eyelid)
with the Conjunctiva Removed.**

1. Origin of the Tensor-tarsi Muscle.
2. Superior Oblique Muscle after passing through its Trochlea.
3. Inferior Oblique Muscle.
4. Attachment of Orbicularis Palpebrarum on Nasal side.
5. Tarsal Cartilages showing position of Meibomian Glands.
6. Opening between the lids known as the Palpebral Fissure.
7. Lower part of Orbicularis Palpebrarum Muscle.
8. The insertion of the Tensor-tarsi Muscle near the Puncta.
9. Lachrymal Sac in the nose.

the following structures, taken in their order from without inward: Integument, areolar tissue, fibers of the orbicularis muscle, tarsal cartilage, fibrous membrane, meibomian glands, and conjunctiva. The upper lid has, in addition, the aponeurosis of the levator palpebrae. The integument is extremely thin, and continuous at the margin of the lids with the conjunctiva. **The Subcutaneous Areolar Tissue** is very lax and delicate, seldom contains any fat, and is extremely liable to serous infiltration.

Eyepiece. The lens or combination of lenses at the eye end of a telescope or other optical instrument through which the image formed by the object glass is viewed.

Eyesight. The sense of seeing; sight of the eye; viewing; observation.

Facultative (fak'-ul-ta-tiv). The power or ability to maintain extra effort whenever called upon.

False Myopia. Due to a spasm of accommodation, where the crystalline lens is kept convexed by the spasm and simulates true myopia.

Far Point. The far point or punctum remotum is the distant point at which an object may be seen clearly, with the muscles of accommodation at rest. Properly speaking, the far point is an optical and not a visual point, and is that point from which rays of light will focus on the retina, the eye being in a state of rest.

Field of Vision. The area or space which the fixed eye can see.

Filtration Angle. (See Iritic Angle.)

Fissure (fis'-yur). A narrow cleft or depression.

Palpebral Fissure. A slit or opening between the eyelids.

Flap Extraction. Removal of cataract by making a flap in the cornea.

Floating Specks. Small floating opacities in the humors of the eye. (See *Muscae Volitantes*.)

Focal (fo'-kal). Pertaining to a focus. **F. Depth,** penetrating power of a lens. **F. Distance,** distance between the center of lens and its principal focus.

Focal Length of Lenses.

Diopters.	English Inches.	Centimeters.
.12.....	320	800
.25.....	160	400
.37.....	108	300
.50.....	80	200
.62.....	60	170
.75.....	52	130
.81.....	48	115
1.00.....	40	100
1.12.....	36	90
1.25.....	32	80
1.50.....	26	65
1.75.....	22	55
2.00.....	20	50
2.25.....	18	43
2.50.....	16	40
2.62.....	15	38
2.75.....	14	35

Focal Length of Lenses—Continued.

Diopters.	English Inches.	Centimeters.
3.00.....	13	33
3.25.....	12	30
3.50.....	11	28
4.00.....	10	25
4.50.....	9	22
5.00.....	8	20
5.50.....	7	18
6.00.....	6½	16
6.50.....	6	15
7.00.....	5½	14
8.00.....	5	12½
9.00.....	4½	11
10.00.....	4	10
11.00.....	3½	9
12.00.....	3¼	8
13.00.....	3	7½
14.00.....	2¾	7
15.00.....	2½	6½
16.00.....	2¼	6
18.00.....	2⅛	5½
20.00.....	2	5

The above table is approximately correct, yet there is a slight difference in close figuring, but is correct as far as the optometrist is concerned; for instance, a +1-D. lens has a focal length of 39.37 in., while we call it 40.

Focus (fo'-kus). The point produced by rays of light passing through a convex spherical lens and coming down to a sharp point of light. *

Folders. A term employed for eye-glasses that can be folded up and placed in a small pocket.

Follicle (fol'-ik-l). A small secretory cavity or sac.

Follicular (fol-ik'-u-lar). Containing follicles. **F. Conjunctivitis.** A form of conjunctivitis marked by the presence of follicles. This occurs generally in children, and is characterized by the formation of small, clear elevations, consisting of adenoid tissue, in the conjunctiva of the lower lid; in some cases they are present also in the retrotarsal fold of the upper lid.

Fontana's Canals or Spaces (fon-tah'-nah). A ring of spaces at the junction of the cornea, iris, and sclera. (See Glaucoma.)

Foramen (fo-ray'-men) (**Optic**). Opening for passage of optic nerve and ophthalmic artery at apex of orbit.

Fornix Conjunctiva. The turn or fold of the conjunctiva.

Fossae Patellaris (pa-tel-la'-ris) (meaning dish-like depression). The depression in the anterior surface of the vitreous body in which the crystalline lens lies. Also called the Hyaloid Fossa.

Fovea (foh'-ve-ah). A small depression. **F. Centralis** is employed to designate the little depression in the center of the macula lutea.

Frame Fitting. There are times when patients complain that their glasses are not comfortable, yet they have the right correction. The cause of the trouble is sometimes found in the improper adjustment of the frames. The fitting of a frame is very important, and if neglected will sometimes destroy the benefit of the most carefully fitted lenses. When a student understands the relation between accommodation and convergence the

value of frame-fitting becomes easily understood. A convex lens, with its curved surfaces, may be described as made up of an infinite number of prisms with their bases meeting at the center; a concave lens, in a like manner, is made up of an infinite number of prisms with their bases outward. When a person looks through the inner side of a convex lens, as he is compelled to do when the frames are too wide for the pupillary distance, he is looking not only through convex lenses, but also through prisms with their bases outward; when the frames are too narrow he looks through prisms with their bases inward. With concave lenses, of course, this condition will be reversed, and besides giving a prismatic effect, will cause the unbalancing of accommodation and convergence.

The subject of frame-fitting has always been and always will be more or less of a problem to the student, but after a little practice and careful attention it becomes a very easy matter. I will here mention a few points which may be of assistance to my fellow-student.

1st. See that the pupillary distance is correct and that the patient is looking through the center of lenses. If glasses are to be worn constantly it is best for the adjuster to stand off, say about three feet, and direct the patient to look between his eyes, so adjusting frames that the patient will be looking through the centers of lenses. For reading glasses the optical centers should be slightly closer and lower, and the top of the lenses must be inclined forward, so as to be as near as possible at right angles to the line of vision. In this way better vision is enjoyed.

2d. The lenses should be placed as near the eye as the lashes will permit.

3d. Never prescribe a small lens for a large face nor a large lens for a small face, but always make the lenses as large as you possibly can without interfering with the patient's appearance, and at the same time see that the pupillary distance is correct. In the fitting of spectacles see that the angle of crest saddles the nose nicely, and that the temples are long enough to go around the ear without showing underneath. See that the temples are not too far from the face and at the same time do not press on the flesh. If you desire to tilt the lenses do not bend temples, but bend the end piece. All glasses should tilt outward from the top, but reading glasses more than distant ones. Cylinders should always be worn as spectacles, as it is very important that they should be held in their correct position.

It is always best for one who is just commencing to practice to supply himself with a full set of measuring frames. They are put up and sold by all wholesale optical houses. The optical houses also supply cards on which are printed the various dimensions. Then by finding a sample frame among your set that about fits your patient you lay it down on the card, allowing for any change you wish to make, and you can easily figure the exact dimensions.

Fundus. The fundus of the eye is the solid structure seen by means of the ophthalmoscope, namely, the retina, the blood-vessels, and the optic disc, collectively.

Fuscin (fus'-sin). A brown pigment of the retinal epithelium.

Ganglion Ciliary (gang'-gle-on). A semi-independent nervous center in the posterior part of the orbit.

Geometrical Center. A point midway between all edges.

Generic Compounds. Lenses having spherical and cylindrical curvatures of the same species; that is, both convex or both concave. Contrageneric compounds have one surface convex, the other concave.

Glabell'a, Glabell'um. Space between the eyebrows.

Gland. A secretory organ. **Lacrima** g., the gland which secretes the tears.

Glass. A hard, brittle, artificial substance formed by the fusion of silica, potash, and lead. Under the best conditions it is quite transparent. Nothing definitely is known as to its origin. The Egyptians used it, and glass has been discovered amongst the ruins of Pompeii.

The media out of which lenses are made. Crown glass for optical lenses, sometimes combined with flint glass.

Glaucoma (glau-ko'-mah). A disease of the eye characterized by increased intraocular tension. In order to fully understand this disease it will be necessary to study thoroughly the anatomy of the eye, and in doing so pay particular attention to Schlemm's Canal and the Spaces of Fontana, situated in the first tunic between the sclerotic and cornea. These canals are said to carry away the excess of aqueous humor. The theory most generally accepted is, that the vitreous humor is formed in the choroid and ciliary body and passes through the hyaloid membrane into the vitreous cavity; from there it filters through the suspensory ligaments into the posterior chamber,

where it becomes watery, and is known as the aqueous humor. After passing through the pupil into the anterior chamber it is said to pass through the Spaces of Fontana into Schlemm's Canal. In this way one can readily see that if the iris was attached to the lens, as it is in cases of iritis, or by the straining of the ciliary muscles, as in hypermetropia, thus closing the Spaces of Fontana, the drainage system would be blocked, while the humors continue forming, resulting in a painful intraocular pressure. Glaucoma may be divided into two kinds, primary and secondary. Primary, when it makes its appearance in a healthy eye, or with a disease like cataract. Secondary, when caused by a disease like iritis. It is a progressive disease, and unless checked by treatment ends in permanent blindness.

SYMPTOMS OF GLAUCOMA. (1) Pain, sometimes of a neuralgic character. (2) Increased tension of the eyeball, sometimes becoming stonelike. (3) Rapid failing of the power of accommodation. (4) Dimness of vision. The pupil is dilated and sluggish. (5) The patient complains of seeing flashes of light and colored halo around a flame or candle. (6) Cupping of the optic disc. (7) Conjunctivitis. The iris also appears steamy. When glaucoma is suspected the patient should be sent to an oculist at once.

The use of atropine causes the iris to crowd into the periphery of the anterior chamber, somewhat occluding the Spaces of Fontana and interfering with the free exit of aqueous humor. As the intraocular tension increases, the stoppage becomes more complete. When the atropine is discontinued the sphincter muscle of the pupil

draws the iris away from the Spaces of Fontana and the normal outlet is again opened. As age advances, the sphincter loses its power, and frequently in old people fails to pull the iris away from the Spaces of Fontana, and this condition may result in glaucoma. For the reasons mentioned it is, as a rule, unsafe to use atropine after the age of from 30 to 35.

Glaucomatous (glau-kom'-at-ous). Of the nature of glaucoma.

Glioma (gly-oh'-mah). A malignant tumor of the retina.

Gliosarco'ma. Glioma combined with sarcoma.

Globulin (glob'-u-lin). A proteid from the lens.

Goggles. Spectacles with wire screens for the eyes.

Goiter (goi'-ter). An enlargement of the thyroid gland. **Exophthalmic g.** (See **Exophthalmic Goiter**.)

Graduated Tenotomy. An incomplete cutting of the tendon of an eye muscle.

Granular Lids (Trachoma). Roughness and soreness of the inside of the eyelids. This roughness is caused by a swelling of the lymph-corpuses forming, as it were, little lymphatic glands or lymphatic follicles.

Gran'ule. A small rounded body. **G. Layer**, one of the layers of the retina.

Haller's Circles. Arterial and venous circles within the eye.

Ha'lo Glaumato'sus. A whitish ring around the optic disc in glaucoma.

Ha'lo Symptom. Seeing of colored rings around lights. This is a symptom of incipient glaucoma.

Hec'tometer. One hundred meters.

Helcol'ogy. Science of ulcers.

Helco'sis. The formation of an ulcer.

Hemeralopia (hem-er-al-o'-pi-ah). An inability to see at night.

Hemiachromatopsia (hem-i-a-chro-mat-op'-si-ah). Color-blindness in one-half, or in corresponding halves, of visual field.

Hemianopia (hem-i-an-o'-pi-ah), **Hemianopsia.** Blindness for one-half the field of vision in one or both eyes.

Hemiopic (hem-e-op'-ik). That condition which affects one eye only.

Hemophthal'mia, Hemophthal'mus. Extravasation of the blood inside of the eye.

Hemorrhage (hem'-or-aj). Escape of blood from the veins or arteries.

Hering's Theory. This is a doctrine which holds that color-perceptions are dependent on a visual substance in the retina, which is variously modified by anabolism for black, green, or blue, and by catabolism for white, red, and yellow.

Heterochromia (het-er-o-kro'-me-ah). A difference in color (in the irides or of different parts of the same iris).

Heteronymous (het-er-on'-im-us). Crossed. (See Diplopia.)

Heterophoria (het-er-o-pho'-ri-a). A tendency of the visual lines away from parallelism. It is subdivided into eight kinds. When the eyes have a tendency to turn in it is known as **ESOPHORIA**; if a tendency to turn out, it is known as **EXOPHORIA**; if a tendency to turn up, it is known as **HYPERPHORIA**; if up and in, **HYPERESOPHORIA**, and if up and out, **HYPEREXOPHORIA**; if a tendency downward, it is known as **cataphoria**; and if down and in, **esocatophoria**; if down and out, **exocatophoria**. Any error of refraction is liable to bring on Heterophoria, and by correcting the error, the Heterophoria will disappear, though it may linger for a month or two.

Heterophthal'mos. That condition in which the irides differ in color.

Heterotropia (het-er-o-tro'-pi-a) (**Strabismus**). This term expresses a stronger meaning than heterophoria, where there is merely a tendency, while in heterotropia there is a positive and visible appearance of the eyes turning, and they may turn in any direction, as in heterophoria. When the eye turns up it is **hypertropia**; if downward, **catatropia**; if inward, **esotropia**; if outward, **exotropia**.

Hippus (hip'-us). Spasmodic pupillary movements, independent of the action of light.

Holmgren's Test (holm'-grens). A color test with a number of different colored yarns representing the various shades of different colors. Used for detecting color-blindness.

Homocentric Rays (ho-mo-sen'-tric). A conic pencil of light-rays.

Homonymous. (See Diplopia.)

Hordeolum (hawr-dee'-o-lum). Sty; inflammation of sebaceous glands of the eyelid.

Horny Epithelium. Trachomatous conjunctivitis.

Horopter (ho-rop'-tur). The field of binocular vision as seen with the eyes fixed.

Hot Eye. Temporary congestion of the eye. This is seen in gouty patients.

Humor. A fluid element of the eye. (Aqueous, crystalline lens, and vitreous.)

Hyaline (hi'-al-in). Glassy.

Hyalitis (hy-al-i'-tis). Inflammation of the vitreous humor or hyaloid membrane.

Hyaloid (hy'-al-oid). That which resembles glass in its transparent qualities. Hyaloid membrane surrounds and encloses the vitreous humor and forms the suspensory ligaments.

Hyaloid Artery. The fetal branch of the central artery of the retina.

Hyaloid Canal, or Canal of Stilling. The canal through the vitreous body, occupied by the hyaloid artery during fetal life.

Hyaloid Fossa. The depression in the anterior surface of the hyaloid membrane in which the crystalline lens lies.

Hyaloid Membrane. The delicate transparent membrane which forms a sac and contains the vitreous humor, and forms the suspensory ligaments of the lens and the Zone of Zinn.

Hydrophthalmia (hy-drof-thal'-mi-ah), **Hydrophthalmus.** Increase in the fluid contents of the eye.

Hydrops (hi'-drops) (dropsy). An abnormal collection of fluid in any part of the body.

Hygroma (hi-gro'-mah). A sac or cyst filled with fluid.

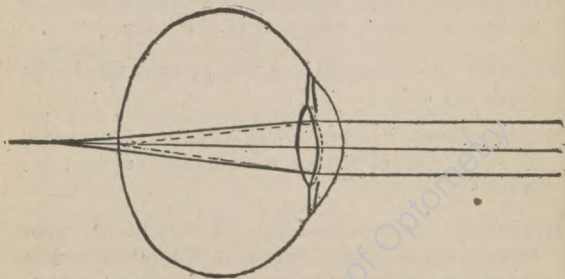
Hyperaesthesia (hi-per-as-the'-si-ah). Over-sensitiveness. **H. of Retina**, over-sensitiveness of the retina.

Hyperemia (hi-per-e'-me-ah). A condition where there is an abnormal fulness of the blood-vessels. **H. of the eyelids** is often a forerunner of inflammation. It is usually accompanied by a slight marginal blepharitis and even conjunctivitis, and if these are relieved the hyperemia to a great extent will disappear.

Hyperkeratosis (hy-per-ker-at-o'-sis). Hypertrophy of the cornea.

Hypermetropia (hy-per-me-tro'-pi-ah) (far-sighted). An error of refraction, where parallel rays of light focus back of the retina with the muscles of accommodation at rest. Subdivided into three classes—latent, manifest

and total. **Latent h.** has no subdivisions; it is hypermetropia that is hidden by cramp of the ciliary muscle, and will not relax without the use of drugs at the time of fitting, but when the correction for the manifest is worn, the cramp begins to relax and more hypermetropia becomes manifest. It may take a week or a year. **Manifest h.** is that part found and corrected with the trial case and retinoscope. It is said to have three subdivisions, namely, facultative, relative, and absolute. **Facultative h.** is where the patient has the ability to overcome his error



A hypermetropic eye. The heavy lines show the focus of parallel rays behind the retina. The dotted lines show the effect of accommodation upon the same rays.

by accommodation, and sees well at all distances. Glasses relieve strain, but do not improve vision in this case. **Relative h.** is where it is possible to accommodate for a near point, by converging to a point still nearer—in fact, by squinting. This eye has blurred vision for close work, and plus spheres improve vision. **Absolute h.** is where the error exceeds the amount of the accommodation, and the patient is unable to bring the focus to the retina, and vision is blurred at all distances.

The correction always improves vision. **Total h.** is the full amount of hypermetropia the patient has. For instance, we correct the eye with the trial case and find 2-D. of manifest; then by the use of drugs relax any cramp; and now find that the same eye has 6-D. of hypermetropia. 4-D. was hidden by cramp. This we call latent, 6-D. being the total amount of hypermetropia.

Hyperope (hi'-per-op). A person who has hypermetropia.

Hyperopia (hi-per-o'-pe-ah). (See Hypermetropia.)

Hyperphoria (hy-per-fo'-ri-ah). The tendency of elevation of one visual axis above the other.

Hyperplasia (hi-per-pla'-ze-ah). Excessive tissue formation.

Hypertropia (hy-per-tro'-pi-ah). Elevation of one visual axis above the other.

Hypertrophy (hy-per'-tro-fy). An abnormal increase in the size of a part or an organ.

Hyphemia (hi-fe'-me-ah). Hemorrhage within the eye.

Hypnogenet'ic. Causing or producing sleep.

Hypnolepsy (hip'-no-lep-se). Abnormal sleepiness.

Hypometropia (hy-po-me-tro'-pi-ah). (See Myopia and Brachymetropia.)

Hypophoria (hi-po-fo'-re-ah). A tendency of a visual line downward.

Hypopyon (hi-po'-pe-on). Pus in the anterior chamber of the eye.

Hypotonia (hi-po-to'-ne-ah). Diminished intra-ocular tension.

Hypotonus (hi-pot'-o-nus). (See Hypotonia.)

Hypotony (hi-pot'-o-ne). (See Hypotonia.)

Identical Points. When the image falls on corresponding points on the retinae of the two eyes.

Iliaqueation (il-lak-we-a'-shun). The curing of ingrowing eyelashes by drawing with a loop.

Illumination (il-lu-min-a'-shun). The lighting up of a place or object for inspection. **Focal i.**, when light is brought to a focal point by lens or mirror. **Axial i.**, when light is transmitted or reflected along the axis of a lens. **Direct i.**, light thrown directly upon the object. **Oblique i.**, when an object is illuminated from one side.

Illusion (il-lu'-zhun). An unreal image presented to the mental vision.

Image (im'-ej). A picture or conception of anything real. **Aerial i.**, image seen as in the air by the ophthalmoscope. **Direct i.**, **Erect i.**, and **Virtual i.**, formed by rays not yet focused. An upright image. **False i.**, image formed on the retina of the deviating eye in strabismus. **Optical i.**, an appearance of an object created by refraction or reflection.

Inad'equacy. Unable to perform allotted function

Incident Ray. The name given to a ray of light before it strikes the second medium.

Index of Refracting. The refracting or bending power of the medium as compared with air, the normal standard, and the index of which is the unit 1. Water as compared with air is 1.33; crown glass 1.52; flint glass 1.62+; pebble, 1.54; diamond, 2.4, the greatest index of any known medium. The transparent parts of the eye in their order are as follows: the cornea, 1.33; the aqueous humor, 1.33; the crystalline lens, 1.43; and the vitreous humor, 1.33.

Infinite Distance. When rays of light proceed from a distance of twenty feet or more they are considered parallel, and are said to come from infinity.

Inflammation (in-flam-ma'-shun). A diseased condition characterized by redness, pain, heat, and swelling. **Traumatic i.**, that which follows a wound or injury.

Infraduction, Deorsumvergence. The power of the inferior rectus muscles.

Infraorbital (in-fra-or'-bi-tal). Situated beneath the orbit.

Instruments and their uses.

Amblyoscope—An instrument to stimulate, exercise, and develop the fusion faculty in strabismus, or squinting patients.

Color Test (Holmgren's)—A set of worsteds, consisting of various shades and tints, for testing color-blindness.

Deviometer—An instrument for determining the degree of deviation in strabismus, or squint.

Keratometer—(See Ophthalmometer.)

Latest Optometer—An instrument combining the advantages of a fixed and revolving-cell trial frame, Stevens Phorometer, Rotary Prism, and Maddox Multiple Rod.

Ophthalmoscope—An instrument with which the interior of the eye may be examined. Also the dioptric and pathological states may be determined. There are many different kinds of ophthalmoscopes; for instance, the Loring is a small hand affair, which contains a mirror and a number of lenses; the self-luminous, by DeZeng, also a hand instrument; and the combined ophthalmoscope and retinoscope, a combined instrument for indirect ophthalmoscopy and for retinoscopy. This is a large machine which stands on a table.

Ophthalmometer or Keratometer—An instrument for determining the amount and axis of corneal astigmatism, an objective test.

Ophthalmometroscope -- An ophthalmoscope with an attachment for measuring the refraction of the eye.

Perimeter—An instrument for measuring the visual field.

Punctumeter—A simple instrument for determining the far point and the near point, therefore the amount of hypermetropia, myopia, or presbyopia. It also indicates the age of the patient.

Savage Monocular Phorometer and Cyclo-Phorometer—Two instruments which together

make a complete appliance for measuring all of the muscles of the eye.

Self-Luminous Retinoscope—An instrument for retinoscopy, self-luminated.

Skiascope—A frame with a series of plus and minus spherical lenses, to be used in place of test frame and lenses when refracting a patient by retinoscopy.

Stevens Phorometer—An instrument for measuring muscular imbalance.

Stigmatometer—An instrument for testing refraction of the eye by the objective method. Also a complete ophthalmoscope for the direct examination.

Insufficiency. Incapacity of normal action within the eye.

Intercilium (in-ter-sil'-e-um). The space between the eyebrows.

Interorbital (in-ter-or'-bi-tal). Situated between the orbits.

Inter'nus. Internal. The internal rectus muscles of the eye.

Interval, Sturm's, or Focal i. In astigmatism, is the distance between the two foci, at which the principal meridians meet.

Intraocular (in-trah-oc'-u-lar). Situated within the globe of the eye.

Intraocular Tension. Pressure from the fluids within the eye.

Intraorbital (in-trah-or'-bit-al). Situated within the orbit.

Ir'idal. Pertaining to the iris.

Iridectome (ir-id-ek'-tom). An instrument used in cutting the iris in iridectomy.

Iridectomize (ir-id-ek'-tom-ize). To cut away a part of the iris.

Iridectomy (ir-id-ek'-to-my). The operation for removing a piece from the iris for the relief of tension of the eyeball in the case of glaucoma, thus producing an artificial pupil.

Iridencleisis (ir-id-en-cli'-sis). An operation for displacing the pupil from its natural position, brought about by drawing the iris into a wound made near the periphery of the cornea, and causing it to become adherent there.

Irideremia (ir-id-er-e'-mi-ah). Defect or imperfect condition of the iris.

Irides (ir'-id-ez). Plural of iris.

Iridesis (ir-id'-e-sis). Strangulation of a part of the iris to form an artificial pupil.

Iridescent Vision. That condition in which variously hued borders are seen surrounding artificial light.

Iridic (i-rid'-ik). Pertaining to the iris.

Iridoavulsion (ir'-i-doh-a-vul'-shun). A term applied to the total removal of the iris when it is completely torn from its periphery.

Iridocele (i-rid'-o-sele). Hernial protrusion of a slip of the iris.

Iridochooroiditis (ir-id-o-ko-roid-i'-tis). Inflammation of the iris and choroid.

Iridocinesis (ir-id-o-sin-e'-sis). The movement of the iris in contracting and expanding.

Iridocyclitis (ir-id-o-syc-li'-tis). Inflammation of the iris and ciliary body.

Iridod'esis. That condition in which a loop of iris is drawn out, and strangulated by a fine ligature tied around it over the incision; the little loop soon drops off, and the result is a pear-shaped pupil, with its broad end toward the center.

Iridodialysis (ir-id-o-di-al'-ys-is). Separation of the iris from the ciliary body.

Iridodonesis (ir-id-o-do-ne'-sis). Trembling condition of the iris.

Iridoncus (ir-id-on'-kus). A tumor or swelling of the iris.

Iridoperiphacitis (ir-id-o-per'-i-fa-si'-tis). Inflammation of the capsule of the lens of the eye.

Iridoplasia (ir-id-o-pla'-ni-ah). Trembling of the iris; iridodonesis.

Iridoplegia (ir-id-o-ple'-gi-ah). Paralysis of the iris. Without defect of accommodation, it usually affects only the action to light, reflex iridoplegia, the associated action remaining. It occurs as a very early symptom in locomotor ataxia, sometimes without any other symptoms of that disease, and should always lead to full investigation. It is probably due to degeneration in that part of the nucleus of the third nerve which presides over the reflex action of the pupil.

Iridorrhesis (ir-id-or-rhex'-is). Rupture of the iris.
Tearing away of the margin of the iris.

Iridosclerot'omy. Puncture of the sclerotic and of the edge of the iris.

Iridotomy (ir-id-ot'-o-my). The operation whereby an artificial pupil is formed by the natural gaping of a simple incision in the iris. Iridotomy is most useful when the iris has become tightly drawn toward the operation scar by iritis occurring after a cataract has been removed.

I'ris. That part of the second tunic which is located in front of the crystalline lens and gives the eye its color and regulates the amount of light which enters. It contains two muscles, the circular (or sphincter), which surrounds the pupil, and is supplied by the third nerve; the radiating muscle (or dilater), which is chiefly supplied by the sympathetic. The iris is suspended in the aqueous humor, which fills the space between the cornea and the lens, thus forming the anterior and posterior chambers.

Iris Shadow. The test for maturity, or ripened cataract; created by oblique illumination.

Iritic (i-rit'-ik). Pertaining to the iris.

Iritic Angle. The angle formed by the junction of the iris and cornea.

→ **Iritis** (i-ri'-tis). Inflammation of the iris, which is usually caused by certain specific blood diseases. It often occurs in the course of ulcers and of wounds and other injuries of the cornea; also with sclerotitis and keratitis.

Irregular Astigmatism. (See Astigmatism.)

Irritant. Causing irritation.

Ischemia (is-ke'-me-ah). Bloodlessness.

Ischemia Retinae (is-ke'-me-ah). Diminution of arteries in the retina.

Isocoria (i-so-co'-ri-ah). Where the pupils in the two eyes are equal.

Isometropia (i-so-met-ro'-pi-ah). The state in which both eyes are alike in their refraction.

Jager's Test Type. The standard type for close print.

Joffroy's Symptom. That condition which exists when patient suddenly turns his eyes upward and there is absence of facial contraction; seen in exophthalmic goiter.

Keratalgia (ker-at-al'-je-ah). That condition in which there is pain in the cornea.

Keratectasia (ker-at-ek-ta'-si-ah). That condition in which the cornea protrudes.

Keratitis (ker-at-i'-tis). Inflammation of the cornea.

Keratocoele (ker-at'-o-cele). Corneal protrusion of Descemet's Membrane.

Keratoconus (ker-at-o-ko'-nus). That condition in which there is a conical cornea.

Keratoglobus (ker-at-o-glo'-bus). A globular protrusion of the cornea.

Keratohelcosis (ker-at-o-hel-ko'-sis). That condition wherein there is ulceration of the cornea.

Keratoiri'tis. That condition wherein the cornea and iris are inflamed.

Keratomalacia (ker-at-o-ma-la'-she-ah). Softening of the cornea.

Keratome (ker'-at-om). A knife for incising the cornea.

Keratometer (ker-at-om'-e-ter). An instrument used for measuring the cornea. It is commonly called the ophthalmometer, of which there are several different makes.

Keratiometry (ker-at-om'-e-try). Measurement of corneal curves.

Keratomycois (ker-at-o-my-ko'-sis). Fungous disease of the cornea.

Keratonyxis (ker-at-o-nik'-sis). Puncture of the cornea.

Keratoplasty (ker'-at-o-pias-ty). Plastic surgery of the cornea.

Keratoscope (ker'-at-o-scope). Instrument for examining the cornea.

Keratotomy (ker-at-os'-ko-pe). Examination of the cornea with a keratoscope. Skiascopy.

Kerectomy (ke-rek'-to-me). Removal of part of the cornea.

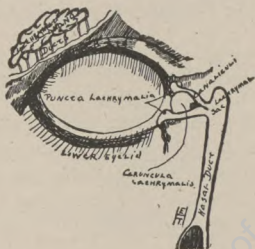
Kilometer. One thousand meters.

Kopiopia or **Copiopia** (ko-pee-oh'-pee-ah). (See Asthenopia.)

Korectomia or Corectomia (ko-rek-to'-mee-ah). The operation for artificial pupil by removal of a part of the iris.

Korectopia (kor-ek-to'pe-ah). Displacement of the pupil.

Koroscopy (ko-ros'-ko-pee). (See Retinoscopy.)



Lachrymal Apparatus. Consists of the lachrymal gland which secretes the tears and the excretory ducts which convey the fluid to the surface of the eye. This fluid after passing over the eye runs through the puncta into the lachrymal canal, then to the lachrymal sac and along the nasal duct into the cavity of the nose.

Lachrymal (lak'-rim-al). Pertaining to tears.

Lachrymation (lak-rim-a'-shun). The secretion and discharge of tears.

Lachrymotomy (lak-rim-ot'-o-my). Operation for incision of lacrimal duct or sac.

Lacrimal, Lacrymal. (Same as Lachrymal.)

Lacu'nar Orbitae. The roof of the orbit of the eye.

La'cus Lacrima'lis. The triangular space at the inner canthus between the two eyelids.

Lagophthalmus (lag-of-thal'-mus). That condition in which it is impossible to close the eyes.

Lakus. The small circular portion at the nasal side of the opening between the eyelids.

Lamina (lam'-in-a). A layer consisting of a flat, thin membrane.

Lamina Cribrosa (lam'-in-a crib-ro'-sa). The perforated area in the sclerotic through which the optic nerve fibers pass to form the retina.

Lamina Fus'ca. The outside layer of the choroid.

Landolt, Edmund, M. D. Ophthalmologist, born in Aaran, Switzerland, in 1846; pursued his professional studies in the universities of Heidelberg, Vienna, Berlin, Utrecht, and Zurich, graduating from the latter in 1869; then worked for more than a year as Horner's assistant in the Zurich clinic for eye diseases; in 1874 he established himself in Paris as an ophthalmologist. His investigations in his specialty have been distinguished by their originality. Among his works are "On the Retina," "A Manual of Ophthalmoscopy," published in French, English, German, and Spanish, "The Refraction and Accommodation of the Eye."

Lapsus (lap'-sus). The dropping of the upper lid, produced by a paralysis of the levator palpebra muscle. Synonym, Ptosis.

Lashes. The name given to the hairs of the eyelids.

Latent (la'-tent). That which is not apparent or manifest. (See Hypermetropia.)

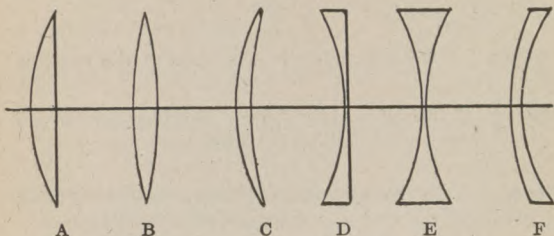
Layer. A stratum having a certain amount of thickness and serving the purpose of a covering.

Leber's Disease (La'-berz). Atrophy of the optic nerve, which is hereditary.

Lema (le'-ma). The dry, hard, yellowish incrustations which collect in the inner canthus.

Lens. The term lens was first applied to any transparent refracting body which had two spherical surfaces, on account of its resemblance to a vegetable known as a lentil. A lens is a transparent substance, crown or flint glass chiefly, through which an object may appear to be increased or decreased in size, and may have either convex or concave spherical or cylindrical surfaces. There are six varieties of spherical lenses—three plus and three minus—all of which can be made the same dioptric power, the only difference being in the shape of the lens. Plus or positive lenses are thickest in the center. Minus or negative lenses are thinnest at their centers. A plus sphere will refract the same in all its meridians and converge parallel rays to a point or focus, while a minus sphere will diverge parallel rays from a point.

The different forms of plus and minus spherical lenses are here represented:



- A. Plano Convex.
B. Biconvex.
C. Periscopic Convex.

- D. Plano Concave.
E. Biconcave.
F. Periscopic Concave.

A line passing through the optical center at right angles to the surfaces of these lenses is not refracted, and is known as the principal axis, while all other rays undergo more or less refraction. A secondary axis is any line which crosses the principal axis at the optical center of a lens. It is not a straight line, but a refracted one, and on emerging takes a direction parallel to that which it would have pursued had it not been interrupted by the lens. **Cylindrical l.**, a lens with refractive power in all meridians but one. This one is known as the axis, and is nothing more than plano glass. The refraction varies from zero at the axis to the full strength, which is at right angles to the axis. **Crystalline l.**, the lens of the eye which resembles a crystal. A transparent double convex lens situated in its capsule behind the pupil between the aqueous and vitreous humor, and when in a state of rest has a focal strength of from plus 19 to plus 20 diopters. **Compound l.**, a lens consisting of two or more lenses made up

together, such as a sphere and a cylinder. **Toric l.**, a lens with power in all meridians, but of different amounts on the same side, usually made extra deep periscopic. **Periscopic l.**, a lens having a convex and concave surface. **Achromatic l.**, a lens composed of two pieces, one of crown and the other of flint glass; the former one being plus and the latter minus, and only half as strong in its refractive power, but of equal dispersive power, and overcomes chromatic aberration. **Aplanatic l.** is on the order of the achromatic lens, except that the minus is divided and placed half on each side of the plus. In this way not only the chromatic but the spherical aberration is overcome, and a perfect lens formed. They are used for high-power instruments. **Bifocal l.** (see Bifocal). **Lenticular l.** is a lens which is plano at the edges, and the power is ground in a space of about half an inch in diameter in the center. When a plus lens is required it is made in the form of a scale and cemented on a plano or simple cylinder. In this way we do away with the thick edge of a high-power minus lens, and it also makes up in a thinner form for a high-power plus, but they are never made up in weak lenses. **Orthoscopic l.**, a lens with two elements a sphere and a prism, so arranged that the amount of accommodation and convergence should exactly correspond.

Lens Capsule. A transparent, highly elastic and brittle membrane which encloses the crystalline lens. It rests in a depression of the vitreous body just behind the iris, and is held in position by the suspensory ligaments.

Lenticonus (len-tik-o'-nus). Exaggerated curvature of the crystalline lens.

Lenticular Astigmatism. (See Astigmatism.)

Lenticular Ganglion (len-tik'-u-lar gang'-gle-on). A small reddish body near the back part of the orbit, between the optic nerve and the external rectus muscle.

Leucoma (lew-ko'-mah). (See Leukoma.)

Leukoma (leu-ko'-ma). White corneal opacity. Albugo.

Le'sion. Any hurt, wound, or local degeneration.

Levator Palpebra Muscle (le-va'-tor pal'-pe-bra mus'-l). (See Muscles.)

Ligament (lig'-a-ment). A tough band of connective tissue, the purpose of which is to connect the bones together or surround them as a capsule. There are several ligaments concerned in the anatomy of the eye. Ciliary Ligament, Palpebral Ligament, External Palpebral Ligament, Internal Palpebral Ligament, Suspensory Ligament or Zone of Zinn, Ligament of Zinn. **The Ciliary l.**, or circle (annulus albidus), is the bond of union between the external and middle tunics of the eyeball, and serves to connect the cornea and sclerotic, at their line of junction, with the iris and external layer of the choroid. It is also the point to which the ciliary nerves and vessels proceed previously to their distribution, and it receives the anterior ciliary arteries through the anterior margin of the sclerotic. A minute vascular canal is situated within the ciliary ligament, called the ciliary canal, or the

Canal of Fontana, from its discoverer. The **Palpebral l.** joins the cartilage of the lids to the orbit the same as the tarsal ligament. The **External Palpebral l.** unites the lid to the outer edges of the orbit. The **Internal Palpebral l.** covers an area including the upper maxilla to the inner margin of the lid. The **Suspensory l.**, or **Zone of Zinn**, surrounds the crystalline lens and holds it in place within the circle of the muscle of accommodation.

Ligament of Zinn. A circular ligament which is attached to the bone at the optic foramen, from which arises the four recti muscles and the superior oblique.

Light. Light is that physical force which, acting upon the sensitive elements of the retina, excites in the mind the impression of vision (or vibrations of ether), and is made up of rays, beams, and pencils.

A **Ray** is the smallest visible line of light.

A **Beam** is a collection or bundle of parallel rays.

A **Pencil** is a number of converging or diverging rays.

Rays emanating from an illuminating or an illuminated point always diverge; in nature there are no converging rays, neither are there any absolutely parallel, but those proceeding from a point twenty feet or farther away are so nearly so that the difference can only be mathematically expressed, and for the purposes of optics are considered as parallel. According to the calculations of astronomers, light moves at the rate of about 186,000 miles in a second; according to this, it

requires about nine minutes for the waves of light from the sun to reach the earth, and those from the nearest fixed star are five years on their journey before they reach us.

From an optical standpoint we now refer to the "Wave Theory," and in order to do this it will be necessary to draw somewhat on one's imagination. You have oftentimes noticed when a stone is dropped into a calm pond of water, it throws forth circular waves in all directions. The first or nearest wave to the stone will have the shortest radius of curvature, or in other words, the greatest strength of curvature. As this wave spreads it will decrease in curvature until it has traveled twenty feet. Beyond 20 feet the waves are considered plane, meaning by this that, when on account of the pupil of the eye being about an eighth of an inch in diameter, we cut from a wave of light that has traveled twenty feet a piece one-eighth of an inch long, that is, the amount that would enter the eye, it would have so slight a curve that it is considered to have none. This is known as a plane wave.

The word minus denotes less; the farther the wave travels from its center the less its curvature, therefore all waves that are going from a point we consider minus, and for the sake of simplicity we must compare the waves of light with the waves of water, and instead of dropping the stone we will light a candle that will throw off waves in all directions. When a wave has traveled one-half inch from a point it has a curve of minus 80, because it has a radius of curvature of $\frac{1}{80}$ metre. Now, as the one and same wave moves on, it loses its curvature; thus

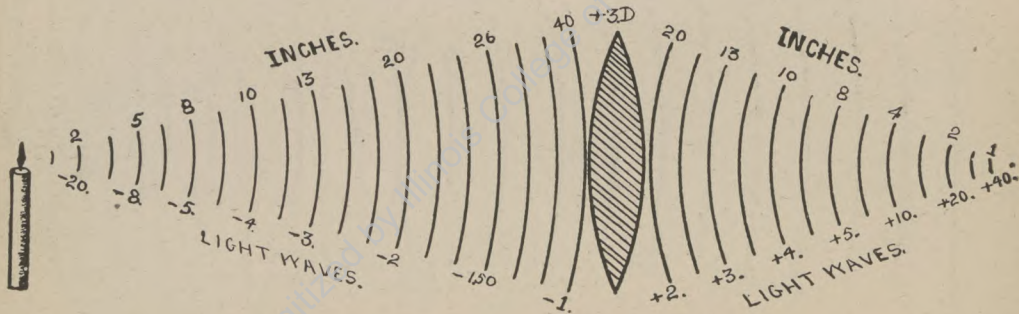
when it has traveled one inch from its center its curvature is less, or -40 , and at two inches, -20 ; three inches, -13 ; four inches, -10 ; five inches, -8 ; twenty inches, -2 ; forty inches, -1 ; eighty inches, $-.50$ (these figures are the fractional parts of a metre, which the distance represents); twenty feet, no curve, or plane wave. Now, if one will stop to think, he will observe these figures compare with the focal length of lenses in the trial case; that is to say, a wave that has traveled forty inches from a point is known as a -1 , and a 1-D. lens has a focal length of forty inches. A wave that has traveled twenty inches from a point is known as a -2 , while a 2-D. lens would focus at twenty inches. For instance, you may ask yourself, "What would be the curvature of a wave of light that has a radius of thirteen inches?" You would at once think of the dioptric number of the lens that would focus at thirteen inches. This would be a 3-D. Then you would say that the curve is -3 if it is going from a point, but if going to a point, $+3$. You will notice that in referring to a metre it is spoken of as forty inches. There is a difference between the two, yet it is near enough for our purpose, and saves the trouble and inconvenience of working with fractions; so far, we have spoken of the minus wave, as all waves in nature are minus; in order to have a plus wave we must use artificial means, and will work out the following example: Place a lighted candle forty inches from a plus 3 sphere; considering the candle the point from which the light comes, the wave has traveled from a point forty inches before it enters the lens, therefore it enters a

minus 1 wave. Minus and plus neutralize. If more plus than minus is present there will remain, after neutralization, an amount of plus equivalent to the difference. Therefore the minus 1 will go through the plus 3 sphere, and will emerge a plus 2 wave, and focus at twenty inches; at the focus they will cross and begin to diverge, or rather become minus.

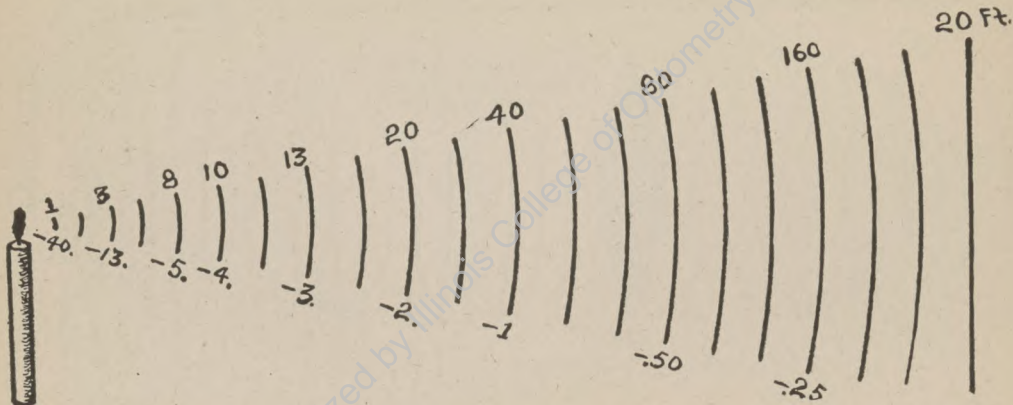
Light travels at the rate of 186,000 miles in a second while in air, but in passing through a denser media, such as glass, its speed is retarded, and it regains its former speed on emerging into air again.

It always depends on how far a wave is from its center of curvature what amount of curve it will have. Study the following examples:

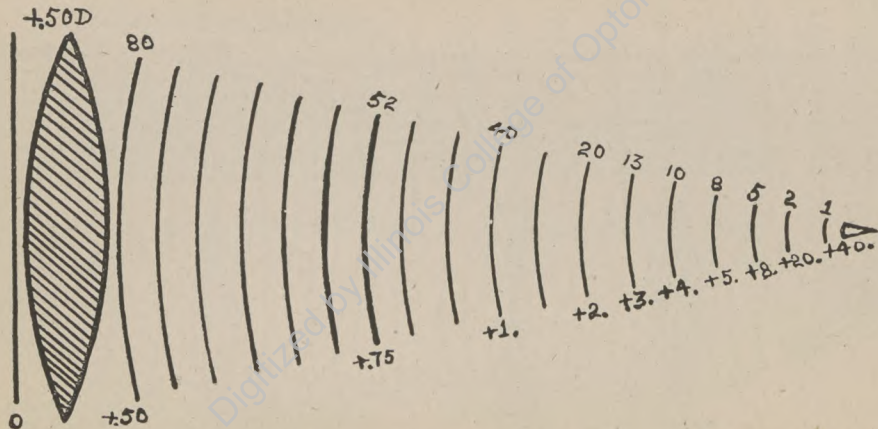
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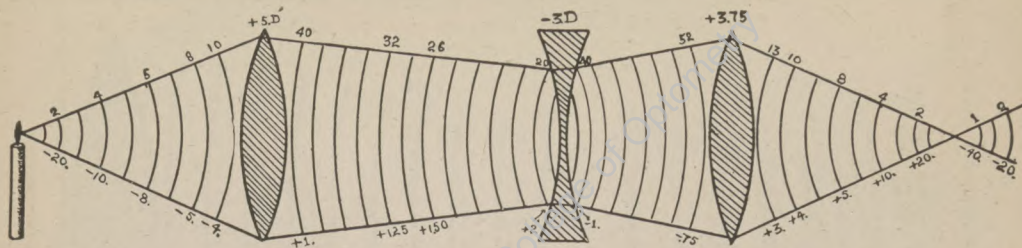
In this example we have what is known as conjugate foci, two focal points attached to one another.



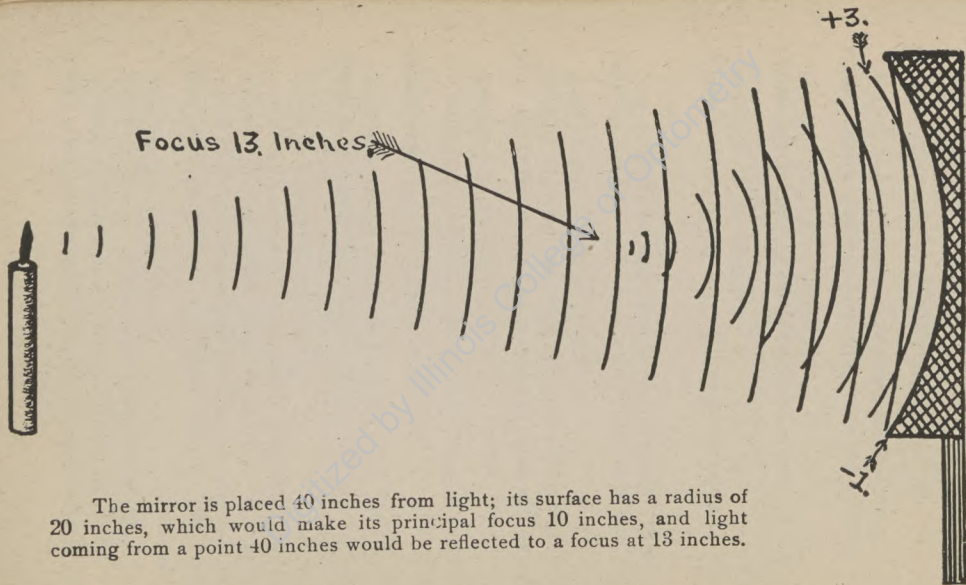
In this example we have waves of light leaving a point or candle and traveling a distance of 20 feet, where they are known as plane waves. The top figures are inches. The waves of light are from their center curvature.



In this example we have a plane wave of light entering a $+.50\text{-D.}$ lens. The wave of light would emerge $+50$ and focus at a point 80 inches distant.



In the above example we have the candle placed 10 inches from a +5 sphere, then a space of 20 in. to the -3 D. sphere. Again a space of 12 inches to the +3.75 D. Now as all waves of light that are leaving a point are minus, the light will enter the first lens with a -4 curve and emerge from it with a +1 curve, which would focus at 40 inches providing it was not interrupted; but as the -3 D. lens is only 20 in. away, the light will enter it with a +2 curve and emerge from it a -1, which we will assume has come from a point 40 in. distant. It has then a distance of 12 in. before entering the next lens, which would mean that it would be 52 in. from its center of curvature as it enters the +3.75 D. It would enter a -.75 and emerge a +3 D. and focus at 13 in. The rays would then cross and begin to diverge, or in other words, pass from + to - waves. The figures above the drawing represent inches from the center of curvature, and those below, the curvature of the waves of light.



The mirror is placed 40 inches from light; its surface has a radius of 20 inches, which would make its principal focus 10 inches, and light coming from a point 40 inches would be reflected to a focus at 13 inches.

Light Area on the Face. The term used to designate the light upon the face when the beam of light from the retinoscope is directed upon the eye under observation.

Light Area in Pupil. The light seen in the pupil of an eye under observation with the retinoscope, caused by the reflex from the retina. Its character and relative movement indicate the refractive condition of the eye.

Limbus Cornea (lim'-bus). (Border line.) The region where the cornea and sclerotic join.

Limit Angle. (See Critical Angle.)

Limitans (lim'-it-ans). That which limits or bounds a body or organ.

Line of Fixation. A line which connects the object looked at with the macula lutea through the nodal point of the eye.

Line of Vision. The line which connects the object looked at with the fovea centralis (visual axis).

Lippitudo (lip-pi-tu'-do). An inflammation of the margins of the eyelids.

Liquor Morgagni. A small quantity of fluid between the lens and its capsule.

Logadectomy (log-ad-ek'-to-my). A removal of a part of the conjunctiva by means of a sharp knife.

Logades (log'-ad-ees). The first coat or tunic of the eye.

Leimophthal'mia. Contagious ophthalmia.

Long-Sightedness. (See Hyperopia.)

Lorgnette (lorn-yet'). Double eye-glasses attached to a handle. This term is often applied to opera-glasses.

Louchettes. A kind of opaque glasses in which, for each eye, there is a small opening which makes it impossible to look in any other way than through this opening.

Loxophthalmos (lok-sof'-thal-mus). That condition in which the eye is turned from parallelism. (Strabismus; Heterotropia.)

Lucifugal (lu-sif'-u-gal). That condition which exists where a person avoids bright light.

Luminous Bodies. Those sources of direct light, as the sun, a lighted candle, etc.

Luminous Pupil. The appearance of the pupil under observation with the retinoscope.

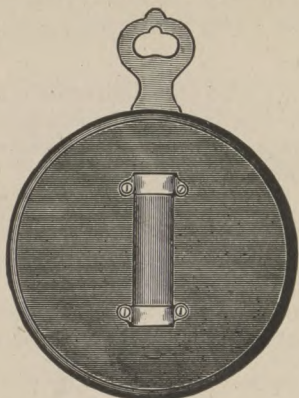
Luxation (luk-sa'-shun) **of Lens.** That condition where the crystalline lens is dislocated.

Macropsia (mak-rop'-si-ah). That condition of an eye in which objects appear larger than they really are.

Macroscopic (mak-ro-scop'-ic). That which may be seen with the naked eye.

Macula Lutea (mak'-yu-lah lew'-te-ah). Also known as the yellow spot or most sensitive spot of the retina, situated on the temple side.

Madarosis (mad-ur-o'-sis). That condition in which the eyelashes are permanently destroyed.



Maddox Rod.

Maddox Rod. An opaque disc with a slit through the center. Over this slit is placed a glass rod or cylinder. In looking through this rod at a small round light, it causes the light to look like a long streak. This rod is used for testing muscular insufficiency. Before testing for muscular imbalance correct all errors of refraction.

Madisterium (mad-is-ter'-i-um). An instrument used for removing the eyelashes.

Magnet Operation. A method used for removing particles of iron and steel embedded within the tissues of the eye, by means of a magnet.

Magnify (mag'-ni-fy). To render an apparent increase in the size of an object.

Malacia (mal-a'-se-ah). Morbid softening of tissue.

Malacocataracta (mal-ak-o-kat-ar-ak'-tah). A soft cataract which forms in the crystalline lens of a person under the fortieth year. This form of cataract is usually the result of injury.

Malaxation (mal-ax-a'-shun). A rubbing or kneading of the eyeball.

Malignant (mal-ig'-nant). Fatal.

Malingeringer. One who pretends to have a defect of vision or some other function to evade duty.

Marginal Keratitis (mar'-jin-al ker-at-i'-tis). A disease of an inflammatory nature which occurs usually in elderly people. The inflammation extends around the rim of the cornea. If the process continues the cornea is invaded by a densely vascular, superficially ulcerated, and yet thickened zone.

Marmarygea (mar-mar'-ij-e-a). Appearance of sparks before the eyes.

Mature (ma-tur'). Fully developed; ripe.

Media. The refracting humors of the eye. Optically, media is the plural of medium.

Medium. Intervening body or quantity. The dioptric media of the eye consist of the cornea, aqueous humor, crystalline lens, and vitreous humor.

Megalocornea (meg-al-o-kor'-ne-ah). That condition in which there is bulging of the cornea.

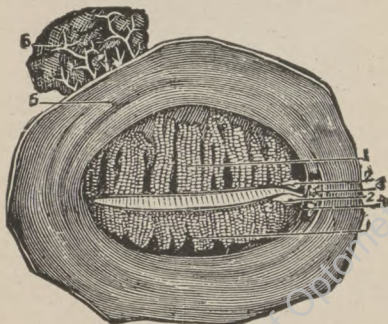
Megalopia (meg-al-o'-pi-ah). (See Macropsia.)

Megalopsia (meg-al-op'-si-ah). That condition of the eye in which objects appear larger than they really are.

Meg'aloscope. A large magnifying lens.

Megascope (meg'-a-skope). A microscope for examining large objects.

Megophthalmus (meg-of-thal'-mus). That condition in which the eye is abnormally large.



ANATOMY OF LIDS.

No. 1. Meibomian Glands. No. 5. Orbicularis Muscles.
No. 2. Puncta Lachrymalia. No. 6. Lachrymal Glands.
Nos. 3 and 4. Lachrymal Canals.

Meibomian Glands (mi-bo'-me-an). A variety of glands which are embedded in the tarsal cartilages. There are from thirty to forty in the upper lid and from twenty to thirty in the lower lid. Their ducts open upon the free margin of the lids. These glands secrete a sebaceous, oily fluid which assists in lubricating the lids as they glide over the eyeball, and also prevents the lids from sticking together when we have them closed. Another function is,

that as the margins of the lids are kept oily at all times the tears do not flow over them so easily. This oily substance also mixes with the tears and assists in preventing friction between the eyeball and lids, and at the same time prevents the cornea from becoming dry so quickly.

Mel'anin. A dark pigment from choroid, hair, and other dark tissues.

Melasma Palpebrarum (mel-as'-ma pal-pe-bra'-rum). A discoloration of the eyelid, which occurs frequently in pregnant women.

Membrana Capsularis. That portion of the arteria centralis, which forms a vascular network and coats the posterior surface of the lens.

Membrana Pupillaris (mem-bra'-na). A membrane covering the pupil in fetal life. This sometimes fails to disappear.

Membrane (mem'-bran). A thin tissue covering some surface or organ.

Membrane Nictitating. That which is sometimes called the third eyelid, to be seen in various animals.

Meniscus Glasses (men-is'-kus). (Or Periscopic.) Glasses that refract at some distance from the center the same as at the center, so that one can see obliquely through them. Minus on one side and convex on the other. Convexo concave.

Menotyphlosis (men-o-tyf-lo'-sis). A condition of the eye in which there is diminution of vision during night.

Meramaurosis (mer-am-au-ro'-sis). A condition of the eye in which part of the field of vision is lost; partial amaurosis.

Meridian (mer-id'-i-an). A meridian of a circle is any one of its several diameters. A meridian of a lens is any line crossing its surface over its optical center. A meridian of the cornea is any line crossing its surface through its anterior pole. A circle describes 360 degrees, one-half of which, or 180 degrees, is marked on trial frame. 0 and 180 are generally found in the horizontal, 90 describes the vertical. On the clock-dial they are numbered from left to right, and on trial frame from the right to the left. The figures on trial frame correspond with clock-dial when they are face to face.

Meropia (mer-o'-pi-ah). (See Amblyopia.)

Mesopter (mes-o-rop'-ter). The position of eyes in state of absolute rest.

Metamorphopsia (met-am-or-fop'-si-ah). That condition of the eye in which objects appear distorted.

Meter Angle. An angle formed by the visual axes of the two eyes looking at a point one metre distant.

Metre Lens. A lens that will focus parallel rays at a distance of one metre.

Metric Curve. A curve that has a radius of one metre.

Microblepharia (mi-kro-blef-a'-ri-ah). A very narrow and thin eyelid.

Microcornia (mi-kro-kor'-ne-ah). A small cornea.

Microlentia (mi-kro-len'-ti-ah). A very small crystalline lens.

Micrometer. An instrument which is used for making measurements of very small bodies.

Micropsia (my-krop' see-ah). That condition of the eye in which objects appear smaller than they really are.

Microphthalmia (my-krof-thal'-mee-ah). Abnormally small eyes.

Microscope (mi'-kro-scope). An optical instrument used for examining minute objects.

Milium. A small elevation, on the skin of the eyelid, filled with a greasy secretion.

Milphae (mil'-phae). A morbid condition in which the eyelashes drop out.

Milphosis (mil-fo'-sis). That condition in which the eyebrows as well as the eyelashes have fallen out.

Minus. Minus lenses, same as concave.

Miosis (mi-o'-sis). Excessive contraction of the pupil.

Miotic (mi-ot'-ic). Any agent or medicine which causes the pupil to contract.

Mirror. An instrument of regular reflection, thus capable of creating images.

Monoblepsia (mon-o-blep'-si-ah). Blindness to all colors but one.

Monocle (mon'-o-kl). A large round glass worn within the socket of either eye.

Monocular (mon-ok'-u-lar). Having one eye only. Monocular vision is that condition where the patient has vision in one eye only.

Moon-Blindness. Amblyopia caused by having the eyes exposed to the full glare of the moon for considerable time.

Monops (mon'-ops). A foetus with but one eye.

Motor. A nerve center controlling motion. A muscle causing motion.

Motor Muscles. The muscles that control the movements of, or parts of, the eyes—the recti, the oblique muscles, the ciliary, and the iris muscles.

Mucocele (mu'-ko-sele). Distention of the lachrymal sac, chronic thickening of the lining membrane, and increased secretion of mucus. The mucus may be clear or turbid. Any tumor containing mucus.

Muscae Volitantes (mus'-cae vol-i-tan'-tes). Small floating bodies, resembling sticks, etc., which move about in the field of vision, but do not actually cross the fixation point, and never interfere with sight. They are usually seen against some bright object. They depend upon minute changes in the vitreous, which are present in nearly all eyes. They vary, or seem to vary, greatly with the health and state of the circulation, but are of no real importance. They are most abundant and troublesome in myopic eyes.

Muscles (Eye). There are six extrinsic muscles that move the eyeball, namely:

INTERNAL RECTUS MUSCLE turns the eye in, and is supplied by the third cranial or motor oculi nerve.

SUPERIOR RECTUS MUSCLE turns the eye up, and is supplied by the third cranial or motor oculi nerve.

INFERIOR RECTUS MUSCLE turns the eye down, and is supplied by the third cranial or motor oculi nerve.

INFERIOR OBLIQUE MUSCLE rolls the eye on its optic axis, drawing the bottom and back part of the eye in and down while the front moves up and out, and is supplied by the third cranial or motor oculi nerve.

EXTERNAL RECTUS MUSCLE turns the eye out, and is supplied by the sixth cranial or abducens nerve.

SUPERIOR OBLIQUE MUSCLE rolls the eye on its optic axis, turning the back part of the eye inward and upward, while the front part moves down and out, and is supplied by the fourth cranial or patheticus nerve.

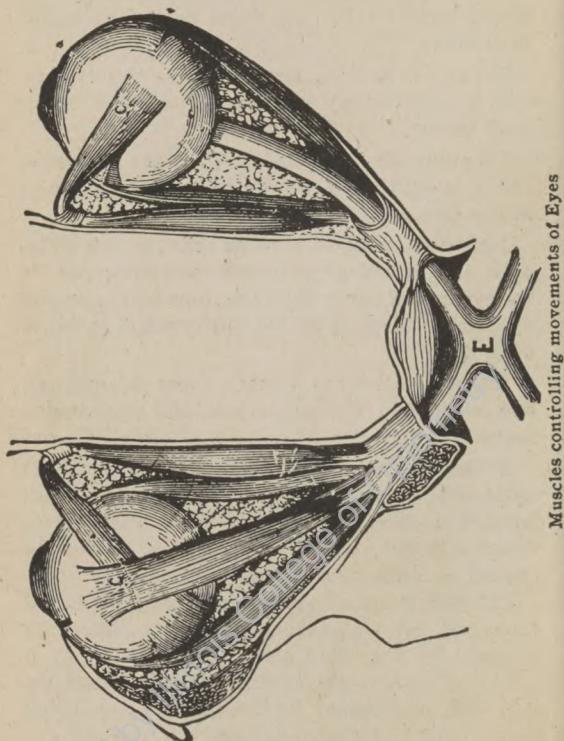
The ciliary muscles are inside the eyeballs, and are used for accommodating only. They are supplied by the third nerve.

The orbicularis palpebrarum muscle closes the lids, and is supplied by the seventh, or facial nerve. (One of the muscles of expression.)

The levator palpebra superioris lifts the lids, and is fed by a branch of the third cranial nerve.

The sphincter muscle which closes the pupil is supplied by the third nerve.

The radiating muscles of the iris which dilate the pupil are supplied by the sympathetic nerve.

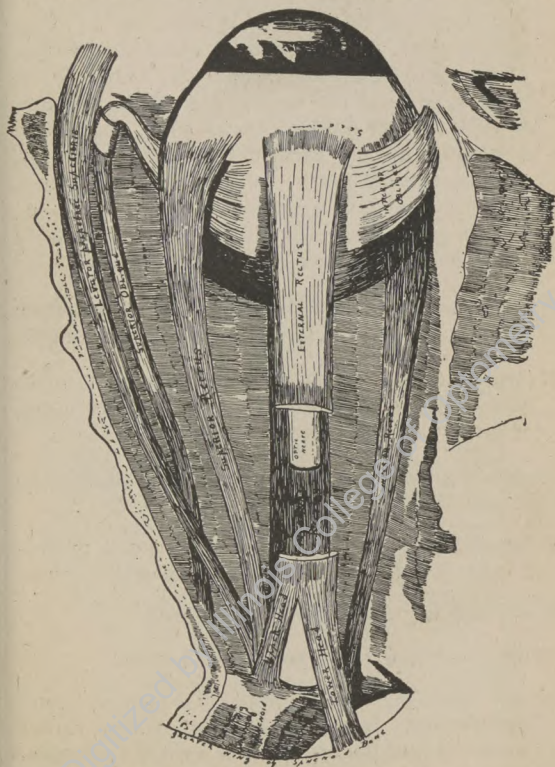


Muscles controlling movements of Eyes

Tensor tarsi compresses the lachrymal sac and pulls the puncta against the eyeball. Supplied by the seventh cranial nerve.

Corrugator supercilii draws eyebrow down and inward, and is supplied by the seventh facial nerve.

Pyramidalis nasi. This muscle depresses the eyebrow. Supplied by the seventh facial nerve.



Cut showing the Extrinsic Muscle.

Muscular Asthenopia. (See Asthenopia.)

Muscular Imbalance. It is generally agreed by the authorities of today that ametropia is responsible for 90 per cent of Muscular Imbalance. For this reason it is considered advisable to always correct any ametropia that may be present, and have the patient wear the correction for at least six weeks. At the end of this time, should any muscular imbalance be manifest, correct half of the amount. Always test for muscle trouble while the patient is wearing his full correction for the ametropia, otherwise it will not be considered a proper test. There are but few exceptions to this rule; e. g., when a prism base in, will allow you to decrease a minus lens or increase a plus, prescribe it.

Mycophthalmia (me-kof-thal'-mi-ah). Inflammation of the conjunctiva, caused by a spongy growth.

Mydriasis (mid-ri'-as-is). Dilatation of the pupil, caused by the use of atropine or other mydriatics, or paralysis of the motor oculi nerve.

Mydriatic (mid-ri-at'-ic). A drug that dilates the pupil.

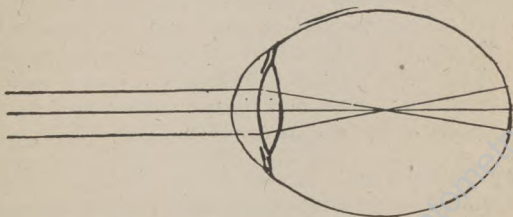
Myiocephalon (my-i-o-sef'-al-on). A small protrusion of the iris through a perforation of the cornea.

Myodesopsia. (See Muscae Volitantes.)

Myope (my'-ope). A near-sighted person.

Myopia (my-o'-pi-ah). Same as brachymetropia and hypometropia. A visual defect which causes parallel rays of light to focus in front of the retina, with the muscles of accommodation at rest. The

eyeball may be too long (axial) or the refraction too great, causing the parallel rays to cross and meet the retina as divergent rays, which form a circle of diffusion, and so cause a blurred and indistinct image of the object. **Myopia** from excess of curvature is much rarer than the axial form. We sometimes see a case of apparent **Myopia** due to excess of curvature of the lens, caused by a spasm of the ciliary muscle. This is what is known as false myopia, and will disappear under the influence of atropine.



These cuts have not been made with mathematical precision, but are merely intended to roughly exemplify the principle involved. The above illustrates the effect of a distant point upon a myopic eye. It will be observed that the rays from the distant point cause the image from that point to spread out over a considerable area on the retina. A million points would make a million blurred spots. They would overlap each other and render the picture indistinct.

Donders pronounced every highly myopic eye a diseased eye, but of late years it has been shown that this remark is liable to convey a false meaning. It is admitted that up to 3-D. the cases are seldom serious, it being generally possible to give perfect vision by proper glasses, but when the case is above 5-D. we do not expect to obtain perfect vision by proper lenses, and look for various pathological conditions.

SYMPTOMS. The patient sees distant objects badly and near objects well. The pupils are usually large, and as presbyopia advances they contract. The eyes look prominent and the patient complains of fatigue, pain, and intolerance of light. All of these symptoms will pass away when the right correction is worn. The ciliary muscle is smaller and weaker than in the normal or emmetropic eye. As a rule myopic patients cannot wear their full correction when first fitted, but after wearing about two-thirds of the correction for about six weeks the full amount may be prescribed. **Myopia** that is gradually on the increase is called **Progressive Myopia**. **Myopia** that is of a rapidly progressive type, and is very destructive to the tissues of the eye, is called **Malignant Myopia**.

Myopic Crescent. As seen by the ophthalmoscope, is a white crescent at the outer side of the optic disc. This condition is caused by the choroid being torn away from the optic disc and allowing the sclerotic to show through. Found in high degrees of myopia.

Myosis (my-o'-sis). Abnormal contraction of the pupil. (Same as miosis.)

Myotic. An agent that will contract the pupil, such as eserine, pilocarpine, etc.

Myotomy (mi-ot'-o-me). The dissection or division of muscles.

Nasal Duct. That part of the tear duct below lachrymal sac, and opening into the nose.

Near Point (or Punctum Proximum). The nearest point at which the eye can see distinctly when employing its full amount of accommodation. It varies with the amount of accommodation the eye possesses. The way to determine the near point is to note the shortest distance at which an emmetrope can read small print with each eye separately. Properly speaking, the near point is that point for which the eyes' refraction is adjusted when the full amount of accommodation is being used.

Near-Sight. (See Myopia.)

Neb'ula. Slight corneal opacity.

Needling (need'-ling). An operation for soft cataract. The lens capsule is needled, and the aqueous allowed to absorb the lens.

Negative (neg'-a-tive). The opposite of positive. The negative surface of a periscopic lens is the concave surface.

Neotocophthalmia (ne-ot-ok-of-thal'-mi-ah). (See Ophthalmia Neonatorum.)

Nephablepsia (nef-ab-lep'-si-ah). (See Snow-Blindness.)

Nephelopia (nef-el-o'-pi-ah). A diminution of vision, caused by a cloudiness of the transparent parts of the eye.

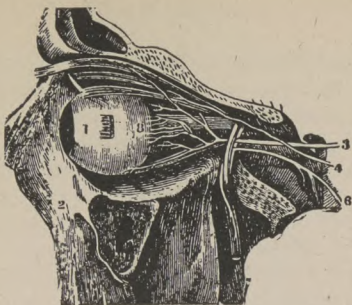
Nephritic Retinitis (nee-frit'-ik). A form of inflammation of the retina associated with Bright's disease of the kidneys, characterized by white streaks along the course of the blood-vessels.

Nerve. A white string-like fiber which transmits impressions from an organ to the brain or from the brain to an organ. **Cranial n.**, any nerve arising from the brain direct. There are twelve cranial nerves, as follows:

1. Olfactory, special sense of smell.
2. Optic, special sense of sight
3. Motor Oculi, motor nerve for eye muscles.
4. Patheticus, motor nerve for superior oblique muscle.
5. Trigemini, sensory, motion, and taste.
6. Abducens, motor nerve for external rectus muscle.
7. Facial, motor nerve for muscles of face.
8. Auditory, special sense of hearing.
9. Glosso-Pharyngeal, sensation and taste.
10. Pneumogastric, sensation and motion.
11. Spinal Accessory, motion.
12. Hypo Glossal,

Motor n., one which contains wholly motor fibers. **N. center**, a group of cells which consist of gray matter and have a common function. **Mixed n.**, a nerve which is both motor and sensory. **N. head**, the optic disc or papilla. **Sensory n.**, any nerve which transmits sensations or impulses. **Sympathetic n.**, any nerve of the sympathetic system.

Nerve (Optic). The nerve that transmits retinal sensations to the centers of perception in the brain, there to be translated into sight. The



**View of the Eye from the Temporal side
with part of the Orbit Removed.**

1. Eyeball with part of external rectus muscle.
2. Superior Maxilla.
3. Third pair (or Motor Oculi) nerves.
They are distributed to all the muscles of the eye except the Superior Oblique, External Rectus and the Dilator Muscles of the Iris.
4. Fourth pair of Nerves, feeding Superior Oblique Muscles.
6. Sixth pair of Nerves, feeding External Rectus.
8. Ciliary Nerves entering the globe.

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nervous system is a system of connection and communication by which the different organs, vessels, and various parts of the body are brought into direct relation with each other and with the mind, and the various organs stimulated to harmonious or alternating action. It consists of the brain and spinal cord, called the central nervous system, which controls the voluntary actions of the body, sometimes called the nerves of animal life, and is directly connected with the sympathetic nerves, which have been termed nerves of organic life, they being involuntary nerves and control the involuntary action of the various vital processes of the body. The nervous system is divided into the cerebro-spinal or central, sympathetic, and the vaso motor. The vaso motor system is a part of the sympathetic system and consists of the vaso motor center located in the medulla oblongata, of certain other subsidiary vaso motor centers in the spinal cord, and of vaso motor nerves. This system is connected with the blood-vessels in the various parts of the body, the muscular coats of which are supplied with filaments and plexuses of vaso motor nerves which regulate the size of the blood-vessels. They are of two kinds: vaso dilators, stimulation of which cause dilatation of the blood-vessels and an increased amount of blood to a part, and vaso constrictors, stimulation of which cause constriction or contraction of the blood-vessels and a diminished amount of blood to a part. This last named system is very important to the practitioners of manipulatory forms of healing, and has only in the past few years been known to any extent,

the vaso motor center being discovered by Schiff in 1855, and more accurately localized by Ludwig in 1871. The cranial nerves are those that have their apparent origin in the cranium. Sommering and other European anatomists name twelve pairs, while Willis and a few other authors designate only nine pairs, according to the order in which they pass out of the base of the brain.

Neuritis (neu-ri'-tis). Inflammation of the optic nerve.

Neurology (nu-rol'-o-je). A study of the nervous system.

Neurodealgia. Pain or excessive sensibility of the retina.

Neurodeatrophia. Atrophy of the retina.

Neuroretinitis (neu-ro-ret-in-i'-tis). Inflammation of the optic nerve and retina.

Neutralize (neu'-tral-ize). The method of counterbalancing or doing away with power in lenses.

In order to determine whether a lens is of plus or minus power, hold it up and look at some distant object through it, then move the lens from side to side and if the object appears to move in the opposite direction to the movement of the lens it is a plus lens. If you wish to find its dioptric power, take from your trial case a minus lens and put them together and again look through them at the object, and should the object still move against the movement of the lenses the minus is not strong enough. On the other hand, should the movement be reversed and now the

objects appear to move with the lenses the minus is too strong, and you must find the minus lens that will allow the object to remain stationary. Whatever minus lens is required to do this will be of the same power as your plus lens; for instance, it will require a -3 sphere to neutralize a $+3$ sphere. When you look at an object through a minus lens, and move the lens as explained above, the object will appear to move with the movement of your lens, and in order to find its dioptric power use plus lenses as in the previous test until all movement of the object looked at has disappeared, and then the minus lens will be the same power as your plus. If the lens is compound, use the weakest spherical lens which neutralizes the motion in one direction; this usually gives the spherical surface, then use a cylinder to neutralize motion at right angles to this. If in order to neutralize a given compound lens, $+2$ sphere combined with $+1$ cylinder, axis 90° is required, then the lens being neutralized is a -2 sphere combined with -1 cylinder, axis 90° , etc.

Nictitation (nik-tit-a'-shun). Involuntary convulsive twitching of the eyelids.

Night-Blindness. (See Hemeralopia.)

Niphablepsia (nif-ab-lep'-si-ah). That condition wherein blindness is caused by the glaring reflection of sunlight upon the snow. Snow-blindness.

No'dal Points. (Or Cardinal Points.) Are two points situated on the optic axis, connecting the centers of curvature of the refracting compound dioptric

system of the eye. The nodal points of the eye are so close together that they may be considered as one point.*

Normal. That which conforms to the natural rule. A straight line drawn from any point of a curve or surface so as to be perpendicular to the curve or surface at the point which it strikes is said to be normal to the surface.

Normal Vision. Vision is said to be normal when an eye can read a line on Snellen's Test Type from the distance at which it is numbered. The smaller the objects that an eye can distinguish or the greater the distance at which it can distinguish an object of given size, the greater is the acuity of vision that it possesses. Suppose, for instance, that the eye is just able to distinguish the letters in the line marked 50 on the Snellen's test type from a distance of twenty feet, then the vision would be 20/50. The vision in this case would not be as good as if the line marked 40 had been read from the same distance; and in order to have normal vision the patient should read the line marked 20 at twenty feet, with each eye separately, then the vision would be known as 20/20. Sometimes the patient will read the line marked 15 or even 10 from twenty feet. In this case the vision is exceptionally acute, and is designated as 20/15 or 20/10.

Normal vision does not indicate that the eye is normal, as the patient may be straining to bring the vision up to this point, as in Facultative Hypermetropia. Again, an emmetropic eye does not always have normal vision.

Nubecula (nu-bek'-u-la). Slight cloudiness of the cornea.

Nuclear Cataract. (See Cataract.)

Nyctalopia (nyk-tal-o'-pi-ah). (See Day-Blindness.)

Nyctotymphlosis (nyk-to-tyf-lo'-sis). State of blindness at night-time.

Nystagmus (nys-tag'-mus). Short, jerking movements of the eye which are very rapidly repeated and always occur in the same direction. The movements of the eye, as a whole, are not affected by it. Defective vision of such cases is not to be attributed to the nystagmus, but, on the contrary, is the cause of it. **Vertical n.**, the eyes continually move vertically. **Lateral n.**, the eyes constantly move horizontally. **Rotary n.**, the eyes constantly rotate.

Obfuscation (ob-fus-ka'-shun). An obscuration of vision or a confusion of sight.

Object. Something visible or tangible. That which is seen. An external something the image of which is upon the retina, which is intelligently impressed and appreciated by the brain.

Objective (ob-jek'-tive). Symptoms observed by operator usually with ophthalmoscope or retinoscope. Symptoms which the refractionist discovers by means of one or more of his five senses. **Objective Examination.** An examination conducted independent of the patient's statements. *e. g.*, retinoscopy.

Oblique. Slanting; placed in a plane between the horizontal and vertical planes.

Occlusion of the Pupil (ok-klew'-zhun). Blocking up of the pupil by a membrane.

Ocular (ok-'u-lar). That which pertains to the eye.

Ocular Refraction. The science treating of the optical conditions of the eye, the estimation of its errors of refraction and their connection with lenses for the eye.

Ocular Spectres. Imaginary objects floating before the eyes.

Oculist (ok-'u-list). A physician and surgeon who has received the degree, "Doctor of Medicine," and makes a speciality of the eye and its diseases.

Oculomotor (ok'-yu-loh-moh'-tor). Pertaining to the movements of the eye.

Oculus (ok'-yu-lus). The organ of vision.

O. D. Oculus Dexter. The right eye.

Offset Guard. An eye-glass guard with a long shank, the purpose of which is to hold lenses farther from the eyes.

Old Sight. (See Presbyopia.)

O'nyx. An accumulation of pus between the layers of the cornea.

Opacity (o-pas'-i-ty). A want of transparency.

Opaque (o-pake'). Impervious to light. Not transparent.

- Operculum Oculi** (o-per-cu'-lum oc'-u-li). The eyelid.
- Operation** (op-er-a'-shun). An act performed with instruments or by the hands of a surgeon.
- Ophryitis** (of-ry-i'-tis). That condition in which the eyebrows are inflamed.
- Ophrys** (of'-rys). Eyebrows.
- Ophthalmagra** (of-thal'-ma-grah). A sudden intense pain in the eye, usually rheumatic or gouty in origin.
- Ophthalmalgia** (of-thal-mal'-ge-ah). Sudden violent pain in the eye, not the result of inflammation, but neuralgic in character.
- Ophthalmatrophia** (of-thal-mah-tro'-fe-ah). Atrophy of the eye.
- Ophthalmia** (of-thal'-mi-ah). Severe inflammation of the eye. This more particularly applies to the conjunctiva of the eyelids and eyeball.
- Ophthalmic** (of-thal'-mic). That which pertains to the eye.
- Ophthalmitic** (of-thal-mit'-ic). That which applies to inflammatory diseases of the deeper as well as the superficial structures of the eye.
- Ophthalmitis** (of-thal-mi'-tis). Inflammation of the eye, more especially the globe with its membranes.
- Ophthalmoblenorrhoea** (-blen-ur-ree'-ah). A flow of mucus from the eye.
- Ophthalmocarcinoma** (-kahr-si-no'-mah). Cancer of the eye.

Ophthalmoceles. (See Staphyloma.)

Ophthalmocopia (-koh'-pee-ah). Fatigue of the eyes; Asthenopia.

Ophthalmodynia (-din'-e-ah). Neuralgic pain of the eye.

Ophthalmography (-mog'-rha-fee). A description of the eye.

Ophthalmologist (of-thal-mol'-o-gist). One who practices ophthalmology and has taken the degree, "Doctor of Medicine." An Oculist.

Ophthalmology (of-thal-mol'-o-gy). A study of the eye and its diseases.

Ophthalmomacrosis (-ma-kro'-sis). Enlargement of the eyeballs.

Ophthalmomalacia (-ma-la'-sha). That condition in which there is abnormal softness of the eyeball.

Ophthalmopathy (-mop'-a-thee). Any disease of the eye.

Ophthalmophthisis (-mof'-thi-sis). That condition in which there is wasting of the eyeballs.

Ophthalmoplegia (-ple'-jah). Paralysis of the ocular muscles of the eye. **O. Partial**, a form in which only some of the muscles are paralyzed. **O. Progressive**, a gradual paralysis of all the muscles of both eyes. **O. Total**, when the iris and ciliary body, as well as the external muscles, are paralyzed. **O. Externa**, when the external muscles are paralyzed. **O. Interna**, paralysis of the internal muscles.

Ophthalmoptoma (-mop-to'-mah). Protrusion of the eyeballs.

Ophthalmorrhagia (-mor-rha'-gee-ah). Hemorrhage from the eye or orbit.

Ophthalmorrhexis (-mor-rex'-is). The bursting of the eyeball.

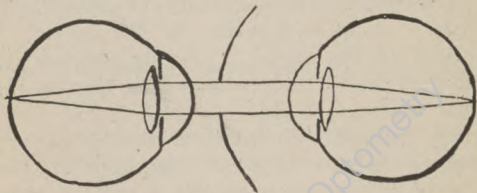
Ophthalmoscope (of-thal'-mo-scope). An instrument for observing the interior of the eye, and thus determining the appearance of the media, the condition of the retina, choroid, and optic nerve, and the state of the refraction.

The Ophthalmoscope consists of a round mirror, with a small perforation in the center. The surface of the mirror is usually concave. The more improved ophthalmoscopes have a reversible mirror, one side of which is flat and the other concave. In addition to this there are located on the back of the ophthalmoscope several wheels which contain a great variety of convex and concave lenses. By rotating these wheels the different lenses contained in them can be thrown immediately behind the aperture in the mirror.

There are two methods of examining the eyes with the ophthalmoscope, viz.: the indirect and the direct.

The indirect method is not of much value so far as estimating the refraction of the eye is concerned, but gives a good view of the fundus of the eye, enabling us to examine in minute detail the optic disc and the blood-vessels of the retina; also to observe whether any diseased condition exists in the interior of the eyeball.

To perform this method successfully, we seat our patient in the dark room and place a light, either an argand gas-burner, an electric light, or any ordinary kerosene student's lamp, at the side and slightly back of the patient's head. If we wish to examine the left eye we place the light on the left side of the patient's head, and if we wish to examine the right eye, on the right side. We place the light just far enough back of the head to avoid illuminating the patient's face. We take our seat in front of the patient and hold our ophthalmoscope at the focal distance of its mirror, reflect the light into the



patient's eye, and look through the sight hole in our mirror. The next step is to place a strong convex lens immediately in front of our patient's eye. With our mirror we illuminate the retina, and the rays emanating from the eye will leave it as parallel rays in cases of emmetropia; as divergent rays in hypermetropia; and as convergent rays in myopia. These rays will be brought to a focus by the convex objective glass which we hold close to the eye under examination.

We direct our patient to look slightly inward while making this examination, in order to bring the optic disc into view. It will be remembered that the optic disc is situated slightly to the

inner or nasal side of the center of the retina, so that when our patient looks slightly inward, the back part of the eye naturally moves outward, bringing the optic disc on a line with our vision. The rays emanating from our patient's eye will be brought to a focus by the convex objective glass.

In the hypermetropic eye the image of the optic disc will look larger than it does in emmetropia, because the rays from a hypermetropic eye are divergent, and will consequently be brought to a focus beyond the focal distance of the convex objective glass, and on slightly withdrawing our objective glass we will note that the size of the optic disc decreases.

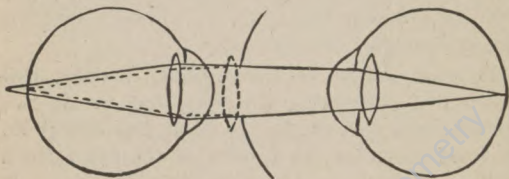
It must always be remembered in using this method of examining the eye, that we do not see the back part of the eye itself, but simply an inverted image of the fundus of the eye formed in the air between the objective lens and our own eye.

In emmetropia the optic disc will look smaller than it does in hypermetropia, and larger than in myopia. On slowly withdrawing the objective lens from the emmetropic eye the optic disc will neither increase nor decrease in size, because the rays which emanate from an emmetropic eye will be parallel, and hence will at all times be brought to a focus exactly at the focal distance of the convex objective glass.

In myopia the image of the optic disc will appear smaller than in emmetropia and much smaller than in hypermetropia. On gradually withdrawing the objective glass the optic disc will increase in size.

In cases of astigmatism the optic disc usually looks oval, and on withdrawing the glass it will increase or decrease more rapidly in one meridian than in one at right angles to it.

In making the direct ophthalmoscopic examination we also use a concave mirror, and arrange the position of the light similar to that described for making the indirect examination, but in this case we place our own eye very close to that of the patient. We place our ophthalmoscope at a distance of about two inches from the patient's eye, and place our own eye immediately



behind the perforation in the mirror. It is necessary in this examination that neither the patient nor the operator shall use any accommodation whatever, and in order that this may be thoroughly accomplished it is well to place the patient under the influence of atropine, assuming that the operator has thorough control of his own accommodation and can suspend it at will.

Upon throwing the light into the emmetropic eye, we illuminate the retina, and a set of rays immediately starts from each point in our patient's retina and passes out of the eye. Each ray of each set is parallel to the other rays in the same set. Therefore, if the operator be

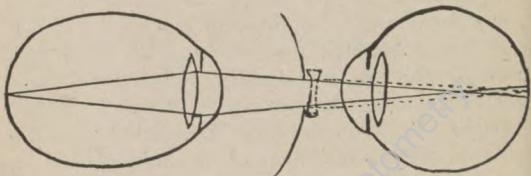
emmetropic himself he will be able to distinctly see the details of the fundus in the back part of his patient's eye, because the rays leave the patient's eye as parallel rays, and the operator's eye being also emmetropic is adapted for parallel rays and hence he has each point on his patient's retina represented by an exact focus on his own retina.

It can readily be seen that if a patient has used any accommodation the rays would leave his eye, not as parallel, but as convergent rays, and therefore the operator would have been unable to distinctly see the details of the fundus. On the other hand, if the patient had been under the influence of atropine and the rays had left the eye as parallel rays striking the observer's emmetropic eye, as parallel rays, they would not focus upon the operator's retina if he had used any accommodation. Hence the necessity of thorough relaxation of accommodation in both the patient and operator.

We will next suppose that the hypermetropic eye is being examined by an operator who is emmetropic. The rays of light will leave the hypermetropic eye as divergent rays and therefore will not focus upon the retina of the observer's emmetropic eye, and hence he will be unable to distinctly see the details of the fundus in his patient's eye. He now rotates the wheel on the back of his ophthalmoscope, throwing different lenses into the aperture of the mirror, until finally he strikes one which enables him to distinctly see his patient's retina. The glass which produces this result will represent the measure of his patient's hypermetropia. In order that the

operator may distinctly see the hypermetropic retina, he must use a convex glass strong enough to render parallel the divergent rays which are leaving his patient's eye.

In myopia the patient's eye is too long, and the rays of light which leave the myopic eye will therefore leave as convergent rays and focus in front of the observer's retina, so that in this case he will also be unable to distinctly see the fundus of his patient's eye, and as in the case of the hypermetropic eye he rotates the wheel on his ophthalmoscope until he is able to distinctly see the retina of the myopic eye. The



glass which accomplishes this result is the measure of the patient's myopia.

In order that he may distinctly see the back of this eye, a concave glass must be used strong enough to render parallel the convergent rays which are leaving the myopic eye.

It is usually conceded that in astigmatism the ophthalmoscope is of little or no value. It is true that we may be able to see the blood-vessels and the edges of the optic disc clearer in one meridian than in another, and that we may use a glass strong enough to render plain the meridian which was at first blurred, and thereby dim the meridian which was first seen plainly. The

glass which clears up the meridian which seemed blurred at first would be the measure of the ametropia in the meridian at right angles to it.

It must also be remembered that if the operator is not emmetropic he must either have his own refraction properly corrected by glasses, or he must make deductions or additions, as the case may be, to or from whatever glass clears up the retina in the patient's eye. For instance, if the operator knows himself to be hypermetropic to the extent of one dioptré, and on examining his patient's eye he finds that a plus 3-D. glass is required to enable him to see the details of his patient's fundus, he then knows that his patient has two dioptries of hypermetropia, because one of the three was required to correct his own eye, and likewise if he had been examining a myopic eye and found that a minus 2-D. lens was required to see his patient's retina, he would know that his patient had three dioptries of myopia, because he himself was one dioptré hypermetropic.

Ophthalmostat (of-thal'-mo-stat). An eye-speculum.

Ophthalmula (of-thal'-mu-lah). A cicatrix located upon the eye or its appendages.

Optic. That which pertains to the science of light, and also to the eye itself, together with its functions.

Optic Atrophy. A partial or total loss of sight due to atrophy of the optic nerve.

Optic Axis. A line drawn through the center of the cornea, through the nodal point to the inner side of the macula lutea.

Optic Nueritis. Inflammation of the optic nerve.

Optical. Pertaining to the organ of vision.

Optical Center. A point on line with the thickest point of a plus sphere or the thinnest point of a minus. A ray of light when passing through the optical center of a lens will always emerge parallel to the incident ray or in the same plane.*

Optical Corrections. Lenses that change the direction of light rays entering the eyes to such an extent that the eyes are adapted to receive and focus them upon the retina, creating artificial emmetropic conditions when ametropic conditions exist.

Optic Commissure (kom'-mis-ur). The linking or joining together of the right and left optic nerve.

Optic Disc. That spot on the retina which marks the entrance of the optic nerves into the eye. It is also called the blind spot, or papilla.

Optic Excavation. The depression in the optic disc.

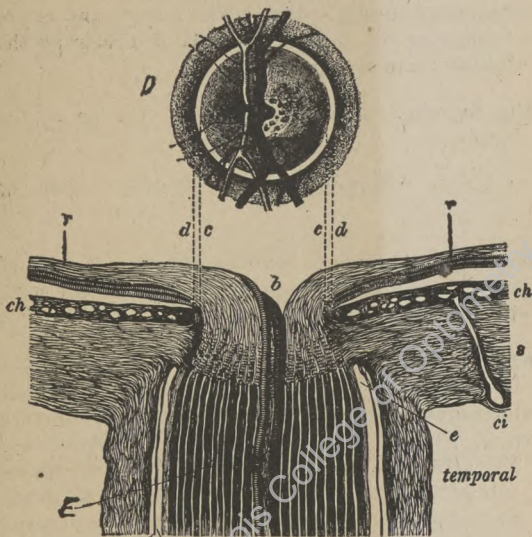
Optic Nerve. The nerve which forms a communication between the brain and the organ of vision. It transmits retinal sensations to the centers of perception in the brain, there to be translated into sight. (See cut, page 135.)

Optic Papilla (pap-il'-lah). The elevation of the optic-nerve head; also called the optic disc and blind spot.

Optician (op-tish'-an). A person skilled in the manufacture of optical instruments.

Optics. That part of the science of physics which deals with the transmission of light, the laws of refraction, reflection, and the phenomena of vision.

Optic Tract. The optic nerve between the visual centers and the optic commissure.



HEAD OF THE OPTIC NERVE.

- D,** Ophthalmoscopic view of the Optic Disc. The small excavations seen around the center is the Lamina Cribrosa. The Papilla is encircled by the white Scleral Ring (c), also the dark Choroidal Ring marked (d).
- E,** Longitudinal Section of Head of Optic Nerve; *r*, the Retina; *b*, Optic Excavation and Canal for Central Artery (porus opticus); *ch*, the Choroid; *E*, Optic Nerve; *e*, the narrow interspace which corresponds to the Scleral Ring seen by the Ophthalmoscope; *s*, Sclerotic; *ci*, Entrance of short Ciliary Artery.

Optist (op'-tist). A person skilled in optometry.

Optogram (op'to-gram). A faint image stamped on the retina for a brief period.

Optometrist. One who measures the eye's refraction.

Optometry (op-tom'-e-try). The science and art of employing the various methods of measuring the optical state of the eye.

O'ra Serra'ta. The anterior limit or edge of the retina.

Orbicularis Palpebrarum. The circular muscle of the eyelids.

Orbiculus Ciliaris. A zone of about one-sixth of an inch in width. It is directly continuous with the anterior part of the choroid.

Orbit (or'-bit). The bony socket in which the eyeball is placed. The orbit is made up of seven bones: the Superior Maxillary, Frontal, Lachrymal, Palate, Malar, Ethmoid, and Sphenoid. The orbits are conical in shape with their apices extending backward and toward each other while the front or base of the cone is open, leaving the eyeballs to be protected by the eyelids in front.

Orbital (or'-bit-al). Pertaining to the orbit.

Origin (or'-ij-in). The more fixed end of a muscle; for instance, the end attached to the bone of the orbit.

Orthochromatic (or-tho-chro-mat'-ic). A term used by photographers denoting that the colors are normal or correct.

Orthometer (or-thom'-e-ter). An instrument for finding the exact relative protrusion of the two eyeballs.

Orthophoria (-foh'-ree-ah). That condition in which the eyes are properly placed with respect to each other. Perfect muscular balance.

Orthoptic (or-thop'-tic). Correcting heterophoria, or strabismus, by means of the prism exercise. This is accomplished by placing the base of the prism over the strong muscle, thus causing the weak muscle to contract or draw the eye toward the apex of the prism in order to see.

Orthoscope (or'-tho-scope). An instrument for neutralizing the refraction of the cornea by examining it through water.

Orthoscopic Lenses. A lens with two elements—a sphere and a prism—so arranged that the amount of accommodation and convergence should exactly correspond.

Orthotropia (or-tho-tro'-pia). Perfect binocular fixation.

O. S. (Oculus Sinister). Left eye.

O. U. (Ocular Unati). Both eyes.

Oxyopia (ox-y-o'-pi-ah). That condition in which the sight is abnormally acute.

Pachyblepharon (pach-y-blef-ar'-on). That condition in which the eyelids have become thickened.

Palpebra (pal'-pe-brah). The eyelid.

Palpebral (pal'-pe-bral). That which relates to the eyelid.

Palpebral Fissure (pal'-pe-bral). The space between the free margins of the eyelids. The outer angle of fissure is called the external canthus; the inner angle, the internal canthus. The small space between the lids and globe at inner angle is called the lacus lachrymalis.

Palpebritis (pal-pe-bri'-tis). An inflammation of the eyelids.

Pannus (pan'-nus). Pannus consists of the new formation of a tissue resembling granulations directly beneath the epithelium of the cornea.

Panophthalmia (pan-of-thal'-miah). An inflammation of the entire eye structure.

Panophthalmitis (pan-off-thal-mi'-tis). General inflammation of the eyeball.

Pantiscopic. A lens tilted outward at the top.

Papilla (pap-il'-lah). A conic elevation observable at the optic-nerve head. **P. Lachrymallis**, the mound at the inner canthus of the eye pierced by the lachrymal puncta.

Papillitis (pap-il-li'-tis). That condition in which there is an inflammation of the optic disc or papilla.

Papilloretinitis (pap-il-lo-ret-in-i'-tis). Inflammation of the optic disc and retina.

Parablepsis (par-ab-lep'-sis). False vision.

Paracentesis Cornea (-sen-tee'-sis). Puncture of the cornea.

Parallax (par'-al-lax). An apparent displacement of an object, due to change in the observer's position.

Parallel (par'-al-lel). That which pursues the same direction, but in a separate path.

Parallelism (par'-al-lel-ism). State of being parallel. That condition in which the visual axes of both eyes lie in nearly parallel paths.

Paral'ysis. That condition in which there is a loss of power of voluntary motion or of sensation in a part from lesion of nerve-substance. **Oculo-motor p.**, where the motor oculi nerve is affected.

Paralysis of Accommodation. That condition in which the function of the branch of the third nerve which supplies the ciliary muscles has been interrupted and the eye cannot accommodate, the ciliary muscles being in a state of rest.

Paralyt'ic. Pertaining to, or affected with, paralysis; a person who is affected with paralysis.

Paresis (par'-es-is). A slight form of paralysis.

Paropsis (par-op'-sis). That condition in which the vision is disordered, and may be due to either a false impression being made upon the retina or a disordered condition of the mind.

Passive. That which is not active; for instance, a muscle that is in a state of rest.

Pathetic (pa-thet'-ik). That which pertains to the feelings. The pathetic muscle is the superior oblique muscle of the eye, which receives its name from the fact that the patheticus, or fourth pair of cranial nerves, control its movements.

Pathological (path-o-log'-i-cal). (See Pathology.)

Pathology (path-ol'-o-je). The science which has for its object the knowledge of disease.

Pediculis Pubis (ped-ik'-u-lus pu'-bis). Crab-louse. In very rare cases they will reach the eyelashes and flourish there. The lice cling close to the border of the lid, and look like dirty scabs; the eggs are darker, and may also be mistaken for bits of dirt. The absence of inflammation and the rather peculiar appearance will lead, in doubtful cases, to the use of a magnifying glass, by which the question will be settled at once.

Pathologic. Pertaining to diseased conditions.

Penumbra (pe-num'brah). A partial shadow.

Perception. The acquiring of impressions through the senses. **Centers of sight p.**, those portions of the brain that are the sources of the optic nerves.

Perceptivity (per-sep-tiv'it-e). Capacity to receive impressions.

Perfection Bifocal. (See Bifocal.)

Pericorneal (per-i-cor-ne-al). That which is situated around the cornea.

Perichoroidal (-koh-roy'-dul). That which surrounds the choroid membrane.

Perimeter (per-im'-e-tur). An instrument for measuring the field of vision.

Periocular (per-e-ok'-u-lar). That which encircles the eye.

Perioptic. (See Periocular.)

Perioptometry (per-e-op-tom'-et-re). Measurement of the visual acuity of the retinal periphery.

Periorbita (per-i-or'-bit-a). That which relates to the lining membrane of the eye socket.

Periorbital (per-i-or'-bit-al). Around or about the eye socket.

Periorbitis (per-e-or'-bi-tis). Inflammation of the lining membrane of the bones of the orbit. Orbital periostitis.

Periosteitis (per-e-os-te-i'-tis). Inflammation of the periosteum.

Periosteum (per-e-os'-te-um). The tough, fibrous membrane investing a bone.

Periphacus (per-if-a'-cus). The crystalline lens capsule.

Periphery (per-if'-er-y). Any outward part or surface; for instance, the border of the cornea or crystalline lens.

Periscopic (per-is-cop'-ic). A lens having a concave and convex surface. Periscopic lenses are also called miniscus lenses; taken from a Greek word meaning a crescent. (See Lens.)

Peritomy (per-it'-o-me). An operation for the treatment of pannus, by removing a strip of the conjunctiva around the cornea.

Perivascular (per-i-vas'-ku-lar). Surrounding a vessel.

Perivasculi'tis. Inflammation of the sheath of a vessel. This is an increase or a hyperplasia of the connective tissue about the vessels, principally, and usually, the arteries.

Perspicillum (per-spic-il'-i-um). An apparatus to enable an individual to see minute bodies, or which will improve the eyesight.

Pescorvi'nus. That which is commonly known as crow's foot; or wrinkles at the outer corner of the eye.

Petit's Canal. The space between the suspensory ligaments in which the edge of the crystalline lens is inserted.

Phaco (fak'-o). Prefix meaning of, or pertaining to, a lens, especially the crystalline lens.

Phacitis (fas-i'-tis). Inflammation of the crystalline lens.

Phacomalacia (fak-o-mal-a'-she-ah). A soft cataract.

Phacometer (fa-com'-e-ter). An instrument for measuring the curvature of lenses, and so determining their refractive power; if they are cylindrical, will locate their axes.

Phacosclerosis (fa-ko-scle-ro'-sis). Hardening of the crystalline lens.

Phacoscope (fa'-ko-scope). An instrument used for viewing the accommodative changes of the crystalline lens.

Phakitis (fa-ki'-tis). Inflammation of the lens. A supposition exists that the crystalline lens may become inflamed.

Phantasma (fan'-tas-mah). A disease of the eye in which imaginary objects are seen.

Phengophobia (fen-go-fo'-bi-ah). (See Photophobia.)

Phimosis (fi-mo'-sis) **Constriction**. Abnormal smallness (as of the palpebral fissure).

Pho'rotone. An instrument for exercising the muscles of the eye.

Phlyctenula (flik-ten'-u-lah). A small vesicle or blister.

Phlysis (fly'-sis). A corneal ulcer.

Phoroscope. An instrument in the form of a head-rest, with a clamp attached so that it may be fastened to a table, and is used as a fixed trial frame.

Phosphenes (fos'-feenz). A luminous sensation, caused by pressing on the eyeball.

Photalgia (fo-tal'-je-ah). Pain in the eye arising from too much light.

Photochromatic (fo-to-chro-mat'-ic). That which pertains to various colored lights.

Photodysphoria. (See Photophobia.)

Photology (fo-tol'-o-gy). The science of light.

Photometer (-tom'-e-tur). An instrument for testing the light sense.

Photonosus (fo-ton'-o-sus). Any disease of the eye which arises from exposure to the glare of light.

Photophobia (fo-to-fo'-bi-ah). Intolerance of light.

Photopsia (fo-top'-si-ah). That condition in which one sees flashes of light. It is caused either by pressure on the eyeballs or by disease of the brain, optic nerve, or retina.

Photoptometer (fo-top-tom'-e-ter). A device for measuring sensitiveness to light by showing the smallest amount of light that will allow an object to become visible.

Phthisis Bulbi (tis'-sis). Shrinkage of the eyeball.

Physiolog'ical. (See Physiology.)

Physiology (fiz-e-ol'-o-je). That department of natural science which treats of the organs of the body and their functions.

Physostigmine (fi-so-stig'-min). The same as eserine.

Pigment. The coloring matter in the choroid coat; the iris, etc.

Pinguecula (ping-gwek'-yu-lah). A small, yellowish elevation, situated in the conjunctiva near the margin of the cornea. Found in old age.

Pin Hole Disc. An opaque disc with a pin hole in the center, found in the trial case. It is placed in the trial frame quite close to the eye under examination. This perforation gives passage to a small pencil of light which passes through the center of the refracting media of the eye. If the patient can see better through the pin-hole the refracting system is at fault, and vision can be improved by glasses. If, on the contrary, vision is not improved, then we suspect a defect in the sensibility of the retina or the transparency of the media of the eye, and lenses will not improve.

Pink Eye. A catarrhal conjunctivitis. The eyeball is of a pink or reddish color. It is a contagious disease which occurs among cattle and horses as well as in man.

Pladaro'sis. That condition where there is a soft tumor on the eyelid.

Plane. When applied to glass a flat surface is meant. A plano-concave lens is a lens having one side concave while the other side is flat. A plane disc, or a plano, is an accessory found in the trial case which has two surfaces, both of which are plane.

Plastic (plas'-tik). Tending to build up tissues.

Plica Semilunaris (ply'-kah). A fold of conjunctiva near inner canthus of the eye.

Point. The far point or punctum remotum is the farthest point at which the eye can see clearly and distinctly with the accommodation at rest. The near point or punctum proximum is the nearest point at which the eye can see clearly

with all of its accommodation in use. **P. of Reversal.** In Retinoscopy, the term is used to designate the point between an erect and an inverted image, where the change from one to the other occurs. Where convergent rays change to divergent rays. The myopic far point in Retinoscopy is where the movement of the reflex appears neutralized. In other words, it is that point on one side of which the shadow movement is different than on the other. For instance, at any position nearer the eye than the point of reversal the shadow will move against the mirror, and at any position farther from the eye the shadow will move with the mirror. This refers to the concave retinoscope. With the flat mirror the movement would be directly opposite. **P. of Fixation.** The point for which accommodation of the eye is adjusted.

Pole. The summit of a spherical surface.

Polarimeter. An instrument for measuring the rotation of polarized light.

Polarization. The production of a condition in light by virtue of which all its vibrations take place in one plane, or in circles and ellipses.

Polychromatic (pol-y-chro-mat'-ic). Possessing many colors.

Polycoria (pol-e-ko'-re-ah). The presence of more than one pupil.

Polyopia (pol-e-o'-pe-ah). Multiple vision.

Pop-Eyed. A large protruding condition of the eyes.

Po'rus Opticus. The opening through the lamina cribrosa through which the arteria centralis retina and veins pass.

Positive. That condition which is real and absolute. The positive surface of a periscopic lens is the convex surface.

Posterior. Behind; back.

Postocular Neuritis. Inflammation of part of optic nerve behind the eyeball.

Presbyopia (pres-by-o'-pi-ah). When as the result of age the power of accommodation has diminished to such an extent that the eye cannot produce three diopeters comfortably, the condition is called presbyopia. The average age when this state of affairs is present is 45, and as age advances the accommodation gradually diminishes and the presbyopia correspondingly increases. The amount of presbyopia is represented by the difference between the number of diopeters of comfortable accommodation present and three diopeters, which must be made good by plus spheres. The presbyope sees well at a distance, providing there is no error of refraction, but has difficulty in maintaining good vision for near work, and the eyes become tired after reading, especially at night. He has trouble in seeing small objects because he has to hold them far away, and consequently gets a smaller visual angle. Before correcting presbyopia it is necessary to test the patient's distant vision and correct any error of refraction. Then place the reading chart in his hand; if he cannot read with comfort at the distance he wishes to hold it, add plus spheres of even amount

in front of his correction until you find the weakest that will allow comfort in reading. The distance for which the presbyope requires glasses will also vary much according to his or her occupation; ordinarily, it is thirteen inches.

Prescription (pre-scrip'-shun). The formula for the lenses required by a patient which are designated by technical characters placed on blanks arranged for this purpose.

Principal Focus. The point where parallel rays of light meet after refraction by a convex spherical lens.

Principal Meridians. The meridians of greatest and least curvature.

Prism. When applied to optics is a wedge-shaped transparent body of glass having two plane sides, employed for the purpose of bending rays of light. A prism is not a lens, and a ray of light is always bent towards the base. It is used in making tests for muscular insufficiencies, and sometimes prescribed for constant wear in cases of heterophoria.

Prism Diopter. A prism which has the power to bend a ray of light passing through it and to a distance of one metre beyond, exactly one centimetre.

Prismatic (pris-mat'-ic). That which has the shape or effect of a prism. When a lens is decentered it will produce a prismatic effect.

Prisoptometer (pris-op-tom'-et-er). An instrument used for testing the refraction of the eye by means of a revolving prism.

Probe. A long slender instrument for exploring wounds. **Lacrimal p.** is a probe designed for use on the tear passages.

Progressive Myopia. Myopia that is gradually on the increase.

Prophthalmos (prof-thal'-mos). A bulging forward or undue prominence of the eyeball.

Proptosis (prop-to'-sis). A falling down or sinking of a part.

Prothesis Ocularis (pro-the'-sis). The insertion of an artificial eye.

Protractor Scale. A device for indicating the location of the axis of a cylinder lens.

Pseudoglioma (seu'-do-gly-oh'-mah). A circumscribed collection of pus in the vitreous.

Pseudoblepsis (seu-do-blep'-sis). That condition in which objects look different from what they really are.

Psorophthalmia (soh-rof-thal'-mee-ah). That inflammatory condition of the eye which is accompanied with itchy ulcerations.

Pterygium (ter-yg'-i-um). A thickening or growth of the conjunctiva, usually on the nasal side of the eye extending out toward the cornea. It can be removed by operation, and should be as soon as it reaches the cornea; otherwise it will grow over it and impair vision.

Ptilosis (ti-lo'-sis). That condition where there is a falling out or loss of the eyelashes.

Ptosis (to'-sis). A drooping of the upper eyelid. This condition is caused by paralysis of that branch of the third or motor oculi nerve which supplies the levator palpebra muscle. It may also be caused by the thickening of the upper lid.

Puncta (punc'-tah). A small prominence or point. (See Puncta Lacrimalia.)

Puncta Lacrimalia (punc'-ta lak-ri-mal'-i-ah). Two small openings near the nasal end of the surface of each eyelid, through which the tear passes into the lachrymal canal.

Punctum (punc'-tum). A fixed point. (See Punctum Remotum and Punctum Proximum.)

Punctum Remotum. (See Far Point.)

Punctum Proximum. (See Near Point.)

Pupil (pu-pil). The central circular opening in the iris. A contracted pupil indicates inflammation of the brain, a sensitive retina, hypermetropia, effect of opium or other drugs. A dilated pupil indicates effect of belladonna or other drugs, myopia, or paralysis of the third nerve.

Pupillary (pu'-pil-la-ry). Pertaining to the pupil.

Pupillometer (pu-pil'-om'-et-er). An instrument for measuring the diameter of the pupil.

Pupilloscopy. (See Retinoscopy.)

Pupillostatometer (pu-pil-o-stat-om'-et-er). An instrument to measure the distance between pupils.

Pyrometer (py-rom'-e-ter). An instrument for measuring high degrees of heat.

Quiz. Instruction by questions and answers. **Q. class,** a body of students forming a class for the purpose of being questioned by a teacher. (See last few pages.)

Radiad (ra'de-ad). Towards the radial side.

Radial (ra'de-al). Of or pertaining to the radius.

Radian. An arc of a circle which is equal to the radius, or the angle measured by such an arc.

Radiant (ra'de-ant). Diverging, as rays from a centre.

Radiation (ra-di-a'-shun). Where rays of light appear to be thrown off from a common center.

Radius. The half of the diameter of a circle.

Range of Accommodation. The distance of a patient's vision, or the range between the near point and the far point.

Range of Vision. The distance between the near and far point.

Ray. The smallest imaginary line of light.

Red-Blindness. That condition in which a person is unable to distinguish red.

Reflection (re-flec'-shun). Throwing back light. Reflection from a plane surface gives an erect image, and the angle of reflection is always equal to the angle of incidence. The image is formed at a distance behind the reflecting surface equal

to the distance of the object in front of it, and is called a virtual image.

Reflection by a concave mirror. Parallel rays falling on a concave surface are reflected as convergent rays which meet at a point called the principle focus. The distance of the focus from the mirror is called its focal length.

Reflection from a convex surface. Parallel rays falling on a convex surface diverge and never meet. No matter what the position of the object before a convex mirror, the image is always virtual, erect, and smaller than the object.

Reflector (re-flec'-tor). A device for reflecting light.

Refracting Media. (See Media.) **R. System.** A lens, or combination of lenses, for the creation of optical images.

Refraction (re-frac'-shun). The bending of a ray of light in passing obliquely from one media to another of different density. **Double R.**, refraction in which the incident ray is divided into two refracted rays. **Static R.**, refraction of the eye at rest. **Dynamic R.**, refraction of the eye, plus that secured by accommodation. (See page 153.)

Refractionist (re-frac'-tion-ist). One who is skilled in correcting errors of refraction of the eye.

Refractive (re-frac'-tive). Pertaining to refraction.

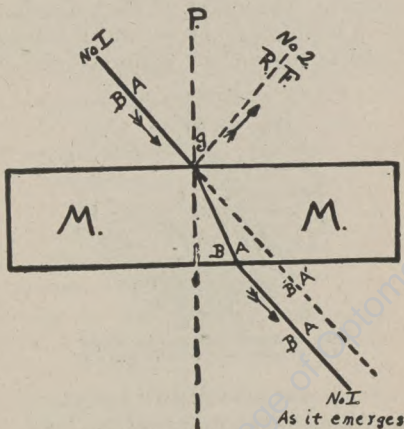
Refractometer (re-frac-tom'-e-ter). An instrument for measuring refraction.

Regular (reg'-u-lar). According to rule; normal.

Relative Index of Refraction is that which is found when light passes from atmospheric air into another medium.

Relaxa'tion. A lessening of tension.

Remedy. Anything acting as a cure for, or the relief from, unhealthy conditions.



REFRACTION BY PLANE SURFACE.

No. 1 ray or light is called the incident before entering the second medium. A ray passing from a rarer to a denser medium is refracted towards the perpendicular, as shown in the above cut. The ray BA is refracted on striking the glass MM, and again refracted on emerging. In passing from a denser to a rarer medium, the ray is refracted from the perpendicular. P represents a ray falling perpendicular to the surface separating the two media. It continues its course without undergoing any refraction.

No. 2 represents the reflected ray. The angle formed by the incident ray with the perpendicular is always equal to the angle of reflection.

The dotted line marked BA' represents the course the No. 1 ray would have taken had it not been refracted.

The side of the incident ray marked B will be found at R in the reflected ray, and A at F.

Reposition (re-po-zi'-shun). The act of putting back in a normal position.

Retina (ret'-in-a). On the inner surface of the choroid, and closely in contact with it, we find the internal or third and most important of the ocular tunics, the retina; to which, indeed, the other two are merely protective or containing membranes. The retina is the immediate continuation of the optic nerve, which extends from the brain to the eyeball, perforates the sclerotic



RETINA
Q - MACULA LUTEA, THE MOST
SENSITIVE PART OF THE RETINA.

and choroid, and immediately spreads out into a thin lamina over the surface of the latter, and is attached at two points only—at the entrance of the optic nerve and at its most anterior border, the ora serrata. The point of entrance of the optic nerve which is known as the optic disc is nearly on the horizontal meridian of the globe, and about one-tenth of an inch to the nasal side of the posterior pole, so that it is the left eye which is represented in the cut under anatomy. The functions of the retina are to receive the pictures which are formed within the eye by means of the waves of light reflected from objects,

and, through the medium of the optic nerve, to transmit the resulting visual impressions to the brain.

Just as the sense of touch is not diffused uniformly over the surface of the body, but is more acute in some parts, for instance, the finger tips, than in others, so also the retina is not equally sensitive to the luminous impressions over its whole surface, but in the highest degree a little to the temple side of the posterior pole, in a part known as the *macula lutea*, or yellow spot, which may be considered the real center of the retina, yet it is to one side. From this spot the sensitiveness gradually diminishes to its most anterior edge. The retina does not extend as far forward as the choroid, but terminates a little in front of the equator, at the posterior border of the ciliary body, in a saw-like margin the rough edge of which is known as the *ora serrata*.

STRUCTURES OF THE RETINA ACCORDING TO GRAY.—From within outwards the layers of the retina are named as follows:

- No. 1. *Membrana limitans interna*.
- No. 2. Fibrous layer, consisting of nerve fibers.
- No. 3. Vesicular layer, consisting of nerve cells.
- No. 4. Inner molecular, or granular layer.
- No. 5. Inner nuclear layer.
- No. 6. Outer molecular, or granular layer.
- No. 7. Outer nuclear layer.
- No. 8. *Membrana limitans externa*.
- No. 9. Layer of rods and cones, or Jacob's Membrane.
- No. 10. Pigmentary layer.

Retinal Reflex. A term used in retinoscopy to designate the light reflected from the retina and creating the light in the pupil.

Retinitis (ret-in-i'-tis). Inflammation of the retina. It is characterized first of all by a diffused cloudiness of the organ. The cloudiness varies very greatly in intensity, although in general it is greatest in the vicinity of the optic disc, because here the retina is thickest. Consequently, the outlines of the optic disc become indistinct and the vessels in the retina hazy. The function of the retina is impaired in proportion to the intensity and extent of the inflammation. In the lightest cases vision may be normal, so that the patients complain simply of the presence of a light-colored cloud before their eyes. But for the most part vision is very considerably reduced both because of the changes in the retina itself and because of the accompanying opacities in the vitreous. The course of retinitis is always rather sluggish. It is only in the lightest cases that the inflammation abates completely within a few weeks, and then the visual acuity may once more become perfectly normal. But for the most part it takes several months for all the inflammatory symptoms to disappear from the retina, while the sight remains permanently impaired. Severe and, more particularly, recurrent inflammations of the retina lead to atrophy of it, pigmentation frequently occurring at the same time (through migration of pigment from the pigment-epithelium). When atrophy of the retina has once made its appearance, the sight is always destroyed, either completely or all except a small remnant, and its restoration is no longer possible.

Retinoscope. (ret'-in-o-scope). An instrument with which an objective examination of the dioptric state or condition of the eyes may be measured. (Made in plane and concave.)

The plane is used for retinoscopy only, while the concave can be combined with a strong plus lens, about 20-D., and used as an ophthalmoscope. There is also a difference in the movement of the shadow in retinoscopy. In working



with the plane mirror between 53 and 60 inches the movement is against in myopia of .75 or more, while in hypermetropia, emmetropia, or less than .75 of myopia the shadow moves with the mirror. With the concave it is just the reverse; the shadow in hypermetropia, emmetropia, and a small amount of myopia will go against the mirror. In more than .75 of myopia, the movement will be with the mirror.

It makes no difference which you use, the findings will be the same, and you deduct from plus and add to minus findings the same amounts; it depends on the distance you are sitting from the patient. When sitting at a little over 40 inches you subtract one diopter from all plus findings, and add $-.75$ to all minus findings. When working between 53 and 60 inches you subtract $.75$ from all plus findings and add $-.50$ to all minus findings.

Retinoscopy (ret-in-os'-co-py). Retinoscopy, or the Shadow Test, is one of the best and most popular methods of estimating the refraction of the eye. We examine the movements of the shadow when the fundus is illuminated by light thrown into the eye from a mirror.

RETINOSCOPY WITH THE CONCAVE MIRROR. The patient is seated in a dark room, with the light placed a little above the head and far enough back so that it will throw no direct rays upon his face. It is best to use a shade around the light to prevent it from illuminating the walls of the room, having a hole an inch in diameter in the front and about the center of the flame. We will now begin with the examination. The first case:

HYPERMETROPIA.—Taking my seat between 53 and 60 inches from the patient, holding the mirror in my right hand before my right eye, I look through the small hole in its center at the pupil of the patient's eye, at the same time reflecting the light from the lamp to the patient's face. The light must not be too strong, but just strong enough to illuminate the eye of the patient. When

you are examining the right eye, have the patient look slightly over your right shoulder, and if the left eye, have him look over your left shoulder. As a result of this arrangement the pupil of the eye under observation is illuminated, and has a reddish color. It is really the illuminated spot on the retina seen through the dioptric media, and is called the fundus reflex, taking its color from the blood-vessels of the retina. The dark non-illuminated areas surrounding it are what are known as the shadows.

Now, if we tilt the mirror from right to left, we will notice the shadow in the pupil move from left to right, and is said to go against the mirror; now we place in the trial frame on the patient's face a plus .50 sphere, and if this does not reverse the shadow, increase its strength until we find the weakest plus sphere that will just reverse its movements; we will say in this case it was +2.50. As we are examining the horizontal meridian we write +2.50 on the horizontal arm of the cross. We now remove the lens and rotate the mirror, working up and down the vertical meridian. The shadow will move against as before, and if there is no astigmatism will require the same amount of plus to reverse it, so we write +2.50 on the vertical arm of the cross.

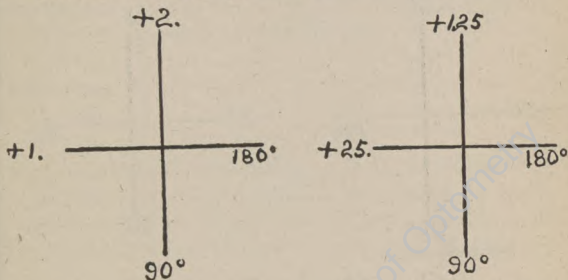
The examination of this eye being finished, we then make another cross, being careful not to change the meridians, and subtract +.75 from each arm, and write the amount remaining on the same arms, but on the new cross; this will be +1.75. From this cross we write the prescription, and having the same power in all meridians, the prescription will be +1.75 sphere.

MYOPIA.—Taking your position as in the previous case, rotate your mirror as before, and if there is less than .75-D of myopia the shadow will move against, and would require plus to reverse it in each meridian. We will say that in this case it required $+ .50$ to reverse the shadow in both meridians. As we subtract $+ .75$ from all plus findings this will leave us $-.25$ in all meridians, which should be the correction for this case.

Should there be .75-D or more, the shadow will move with the concave mirror, and must be reversed with the weakest minus lens in each meridian. In this case it required -1.50 to reverse the shadow in the horizontal meridian, and the same amount for the vertical. Then we make a cross as before and add $-.50$ to each arm. This would make it -2 in all, and the prescription would be -2 sphere.

ASTIGMATISM.—Is a difference of refraction of the meridians of an eye, one meridian of the eye possessing a greater dioptric value than the one at right angles to it. It is evident that in examining such an eye with the retinoscope, the observing eye cannot watch both meridians at the same time. Whenever there is astigmatism the shadow will move faster in one meridian, and the reflex will have a band-like or straight edge. If this bright band is seen straight up and down in the vertical meridian, it will move faster across the horizontal meridian, and if the shadow moves against the mirror, we will use a plus cylinder, placing the axis parallel with the bright band; in this case it would be the 90th meridian. Had the shadow moved with the mirror, we would have used a minus cylinder; but in either case

increase the strength of the cylinder until you find the weakest that will just reverse the movement of the shadow. Then leaving this cylinder in its position, work through its axis and reverse the shadow in this meridian with another cylinder, placing the axis at right angles to the one already in the trial frame, which would be the 180th meridian in this case. Now, as you have just reversed the 2d meridian, make a cross on your paper, having its meridians correspond to those examined in the eye, and on each arm write the



power it required to just reverse the shadow. In doing this take no notice of the axis of your cylinder. The cross you have already made is known as the retinoscopic findings, so you must make another cross as before and subtract .75 from all plus findings, and to minus findings add $-.50$, and the remainder write on the arms of the new cross, being careful not to change the meridians. From this cross you write your prescription. We will say in this case that the retinoscopic finding was $+2$ in the vertical, or 90th meridian, and $+1$ in the horizontal meridian. Now, as we have to subtract .75 from all

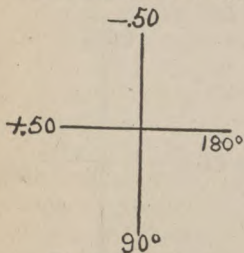
plus findings it will leave us $+1.25$ in the vertical meridian and $+.25$ in the horizontal meridian of the prescription cross. From these findings, we write the prescription without changing the optical value of the cross.

The prescription in this case would be

$+1.25$ sph. $\ominus -1$ cyl. ax. 90° .

or $+.25$ sph. $\ominus +1$ cyl. ax. 180° .

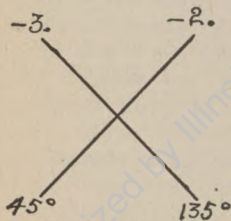
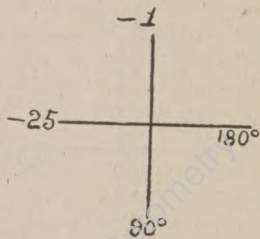
The cylinder always represents the amount of astigmatism in the eye. The following are a few cases as examples:



Prescription—

-1 sph. $\ominus +.75$ cyl. ax. 90° .

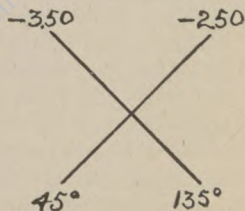
or $-.25$ sph. $\ominus -.75$ cyl. ax. 180° .



Prescription—

-3.50 sph. $\ominus +1$ cyl. ax. 135° .

or -2.50 sph. $\ominus -1$ cyl. ax. 45° .



Retractor (re-trac'-tor). An instrument used for drawing and holding the parts away while undergoing an operation, or for any other purpose.

Retrobulbar (re-tro-bul'-bar). That which is situated or occurring behind the eyeball.

Reversal Point. (See Point of Reversal.)

Rheum (rume). A watery discharge from the eyes.

Rhodopsin (ro-dop'-sin). Visual purple; pigment of outer segment of retinal rods.

Rhytidosis (rit-id-o'-sis). A wrinkling, as of the cornea.

Rod. Relates to the retina. It is one of the cell elements of which Jacob's Membrane is composed: These minute bodies are cylindrical in form, hence the term, rod (rods and cones).

Romberg's Symptoms. Difficulty in standing when the eyes are shut: a sign of locomotor ataxia.

Rota'tion. Process of turning around an axis.

R. of the Mirror. A term used in retinoscopy to indicate the movement of the mirror to create a movement of the light area.

Sac. A bag-like organ.

Saemisch's Ulcer (sa'-mish-ez). Infectious corneal ulcer.

Sarcoma (sar-ko'-mah). A tumor made up of a substance like the embryonic connective tissue. It is often highly malignant. **Sarcoma** of the ciliary body is generally pigmented, and often passes unobserved until it attains considerable size as a brown mass, which was at first concealed from view by the iris. Occasionally it makes its first appearance at the angle of the anterior chamber.

Schematic Eye (ske-mat'-ik). A model or diagram of the eye.

Schlemm's Canal. A lymph channel in the first tunic, between the cornea and the sclerotic. (See Anatomy.)

Scintillation (scin-til-la'-shun). A sensation of sparks before the eye.

Scissors Movement. A peculiar movement of the retinal reflex, resembling the opening and shutting of a pair of scissors. It indicates a condition of irregular astigmatism.

Sclera (skle'-ra). The external coat of the eyeball, or sclerotic.

Scleral. Pertaining to the sclera.

Sclerectasia (skle-rec-ta'-si-ah). A bulging state of the sclera.

- Sclerectomy** (skle-rek'-to-my). Excision of a portion of the sclera.
- Sclerectasis** (skle-rek'-ta-sis). A protrusion of the sclerotic coat. (See Staphyloma.)
- Scleriritomy** (skle-rir-it'-o-my). Incision of the sclera and iris in anterior staphyloma.
- Scleritis** (skle-ri'-tis). Inflammation of the sclerotic coat.
- Sclerochoroiditis** (skle-ro-cho-roid-i'-tis). Inflammation of both the choroid and the sclerotic coats of the eye.
- Scleroconjunctival** (skle-ro-con-junc-ti'-val). That condition in which the sclera and the conjunctiva are concerned.
- Sclerocorneal Sulsus** (furrow). The angle or depression formed by the difference in the radius of curvature of the sclerotic and cornea. This angle makes the eyeball stronger and more firm at this point, and it is just inside this angle that the ciliary muscles are attached.
- Sclerocorneal** (skle-ro-cor'-ne-al). Relating to the sclerotic coat and cornea.
- Scleroiditis** (skle-ro-i-ri'-tis). An inflammation which involves both the iris and sclera.
- Sclerokeratoiritis**. Inflammation of the sclera, cornea, and iris.
- Scleronyxis** (skle-ro-nyx'-is). A perforation of the sclerotic coat.

Sclerophthalmia (skle-rof-thal'-mi-ah). That condition in which the sclera overlaps the cornea, so that only a portion of the latter remains clear.

Scle'rosed. That condition in which a part is affected with sclerosis; a hardening.

Sclerotic (skle-rot'-ic). The posterior five-sixths of the first tunic. It is firm, hard, and opaque; known as the white of the eye. It serves to give shape to the globe, protects its more delicate interior, and at the same time acts as a dark-box or camera. It is to this coat that the muscles are attached. The sclerotic is thickest in the posterior part, where it has a thickness of about one millimetre. It gradually diminishes in thickness toward the anterior part, becoming somewhat thicker near the cornea, because here the tendons of the recti muscles are attached and fused with it. The sclerotic consists of fine cotton-like fibers or connective tissues, which are united into bundles which seem to be woven in all directions. Between the bundles are found lymph-spaces, which are in part lined with fat cells.

Scleroticectomy (skle-rot-i-kek'-to-my). An operation for cutting through any part of the sclerotic.

Scotodinia (sko-to-din'-iah). Dizziness, with headache and dimness of vision.

1 **Scotoma** (sko-to'-mah). That condition in which there is a blind or partially blind area in the visual field. Sometimes the patient will complain of seeing dark, vanishing cloudy spots before the eyes. **Absolute s.**, a part of the visual field in which there is absolute blindness.

Scotometer (sko-tom'-e-ter,. An instrument for measuring scotoma.

Seborrhea (seb-or-e'-ah). An abnormal secretion of the sebaceous glands.

Seg'ment. A section of a circle. A cylindrical lens is a segment of a cylinder which refracts rays of light in all meridians but one. This meridian is known as the axis. A spherical lens is a segment of a sphere. A segment of anything is one of the parts into which it is divided.

Serpiginous (ser-pij'-in-us). Resembling a ring-worm.

Shadow Test. (See Retinoscopy.)

Sheath. A tubular case or envelope. **Optic s.,** the covering of the optic nerve formed by the dura mater on the outside, and the pia mater on the inside, of the subarachnoid space.

Shortsightedness. (See Myopia.)

Sight. The sense by which external objects are located and seen, their color, size, and form described, as compared with other objects, through the medium of the visual organ.

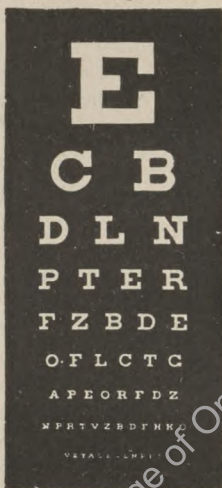
Sign. That by which anything is represented. The sign of addition (+) represents convex spherical and convex cylindrical lenses. The sign of subtraction (—) is used to represent concave spherical and concave cylindrical lenses.

Sine. (A bent surface, curve). Length of a perpendicular drawn from one extremity of an arc to the diameter drawn through the other extremity; the perpendicular itself.

Sinis'trad. To or toward the left.

Skiascope (ski'-as-kope). Better known as the retinoscope.

Skiascopy. (See Retin~~e~~scopy.)



Snellen Chart.

Snellen, M. D., Prof. H. Born in Holland. A professor of ophthalmology occupying the chair at the University at Utrecht, Holland. A pupil of Dr. F. C. Donders, whom he succeeded in practice and his professorship. He devised a chart consisting of letters and symbols by which the subjective means of measuring the range of vision could be uniformly and scientifically determined. It is held by Snellen that in order to distinguish one letter from another the eye must be able to distinguish the spaces between

the lines which correspond to a visual angle of $1'$. This is true for certain letters, as, for instance, to differentiate between O and C, where the eye must distinguish the white space which interrupts the circle in C. The same is true for E and F, but the principle is not applicable to the other letters of his series. In a lecture on refraction by Landolt, we learn of what great advantage it is to determine the visual acuteness and the refraction at the same time. We must determine the refraction at such a distance as shall exclude the accommodation as much as possible. For this a distance of twenty feet, or six metres, is necessary. We therefore place our test type at 20 F, and see what are the smallest characters which each eye, separately, can distinguish. These types are so designed that at the distance at which they should be seen they each subtend an angle of $5'$ at the eye. And when the letters marked 20, or 6 M, are read from 20 F, vision is said to be normal, and an eye with normal vision can read any of the letters on the chart at the distance at which they are marked.

Snow-blindness. Long exposure of the eyes to the glare from snow gives rise to an acute conjunctivitis, attended with intense pain, photophobia; and occasionally conjunctival hemorrhages.

Socket (sok'-ket). A hollow part into which a corresponding part fits.

Spasm. An involuntary contraction of a muscle. Spasm of accommodation is a spasmodic contraction of the ciliary muscles, thus increasing the

convexity of the crystalline lens and making the eye appear to have a higher refractive power. There are two kinds—tonic and clonic. **Tonic s.** is where the spasm persists for a considerable time, and **Clonic s.** is where the muscles contract and relax intermittently.

Spectacles. A pair of lenses mounted in frames with temples attached.

Spectrum (spec'-trum). The analysis of the seven colors which after passing through a prism become separated.*

Sphere. A lens with the same power in all meridians. There are three ways to grind a plus or minus sphere of the same value; namely, bi-concave, plano-concave, periscopic-concave, bi-convex, plano-convex, periscopic-convex. (See Lenses.)

Spheroid (sphe'-roid). That which resembles a sphere in shape.

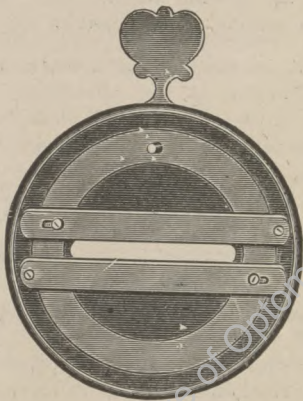
Spherometer. An apparatus for measuring the curvature of a surface.

Sphincter (sphinc'-ter). A ring-like muscle. The sphincter muscle of the iris when contracted closes down the pupil. When relaxed allows the pupil to become dilated.

Spinttherism (spin'-ther-ism). That condition in which the patient complains of seeing star-like flashes of light.

- Squint.** Cross Eyes. Strabismus. A condition in which there is a deviation of the visual axis of one of the eyes from the correct position of fixation when looking at a point. The deviation may occur in any direction. (See Concomitant Strabismus.)
- Staphyloma** (sta-fy-lo'-mah). A bulging of the cornea or sclera. **Anterior s.**, a bulging forward of the anterior portion of the eye. **Posterior s.**, backward bulging of the posterior pole of the eye.
- Stat'ic.** Not in motion; in a state of rest. The static refraction is the refraction of the eye with the muscles of accommodation at rest; just the reverse to dynamic refraction.
- Steato'sis.** That condition in which we have fatty degeneration; disease of the sebaceous glands.
- Stenopaic Slit** (sten-o-pa'-ic slit). An accessory to be found in any complete trial case, and consists of an opaque disc with a slit about an inch long and one millimetre wide. It is used by some refractionists for the purpose of finding the two principal meridians in cases of astigmatism. The disc is placed in the trial frame in front of the eye we are about to examine. The patient is requested to look steadily at the distant chart. The disc is then slowly rotated until a complete circle of the eye is made, after which it is always best to allow the patient to rotate it for himself, and to stop when the best vision is obtained. This would be considered one of the principal meridians. We then try convex spheres in front of the slit. If this meridian should show hypermetropia we continue to in-

crease the plus until we find the strongest that will allow the best vision. We then take note of the number or meridian on the trial frame, and make a cross on a piece of paper at the same angle as the slit was placed in the frame, and write on the arm of each, the power of the lens required for correction. So far we have only tested one meridian. We now rotate the slit 90 degrees and



correct this meridian as before, writing down the power of the lens used on the second arm of the cross. Now from this cross we write the prescription without adding or subtracting, as we do in cases of retinoscopy.

Stereoscope (ster'-e-o-scope). An instrument composed of two prisms arranged in such a way that two separate pictures of the same kind may be seen as one. This instrument makes the picture more natural, as the objects appear to stand out.

- Stereoscopic Vision** (ster-e-o-scop'-ic). Where we have equal vision with the two eyes and the objects appear to stand out in solid form, and are not seen as flat pictures.
- Stilling's Canal.** A small canal leading from the optic disc through the vitreous humor to the lens of the eye. (See Anatomy.)
- Stillicidium** (stil-li-sid'-i-um). An overflowing of the tears upon the cheek due to a stricture of or a narrowing of the nasal duct. (Same as epiphora.)
- Stilus** (sti'-lus). A small instrument made of gold or silver used for dilating the lacrimal duct.
- Stoke's Lenses.** An instrument that was used in the diagnosis of astigmatism.
- Stop-needle.** A needle with a disc attached to regulate the depth of penetration.
- Strabismometer** (strab-is-mom'-e-ter). An instrument for measuring the degrees of strabismus.
- Strabismus** (stra-bis'-mus). That condition in which the eyes turn away from parallelism. This condition can be seen by an observer. The cause of strabismus may be due to an uncorrected error of refraction, for when a person has an error of refraction in one eye that interferes with the vision of its fellow, he will learn to turn the eye with the error to one side. **Concomitant s.** is that form of strabismus in which one eye, although deviated, always moves with the other, so that the amount of deflection remains the same. **Paralytic s.** is due to paralysis of one or more of the extrinsic muscles, and the eye remains sta-

tionary. Hypermetropia is responsible for 80 per cent of converging strabismus on account of the ciliary muscles and the internal rectus muscles being supplied by one and the same nerve.



One Eye turning in.



Both Eyes turning in.



Both Eyes turning out.

When the eye attempts to accommodate in order to overcome the hypermetropia, the internal rectus will contract, and if the patient has not the nerve energy to control the external rectus, the eye will turn in.

Strabotomy (stra-bot'-o-my). An operation calling for the cutting of an ocular tendon for relief in cases of strabismus.

Strain. Injury from over-use.

Stye. Inflammation of a sebaceous gland of the eyelid. It lies near the border of the lid, and corresponds to the inflamed gland. In a day or two the swelling at this spot increases, and the skin over it grows red, afterward shows a yellowish discoloration, and finally is perforated near the border of the lids, with a discharge of pus. After the evacuation of the pus the inflammatory symptoms rapidly abate, the small abscess-cavity soon closes, and the entire process comes to an end. Eye-strain is a common cause.

Subarach'noid Space. That space between the dura mater and the pia mater which forms the optic sheath and the Capsule of Tenon.

Subconjunctival (sub-con-junc-ti'-val). That which is situated just beneath the conjunctiva.

Subjective (sub-jec'-tive). That which pertains to, or is perceived by, an individual. Not perceptible to any other person. It refers to the patient as he sees objects or feels concerning his own impressions.

Subla'tio Ret'inae. Detachment of the retina.

Subluxa'tion. Where the lens of the eye is a little displaced, subluxation may consist in the lens being turned a little obliquely, so that one end of it looks somewhat forward. This condition may be recognized from the unequal depth of the

anterior chamber. In cases of luxation, that is, where the lens has left its place in its capsule, so that it partly covers the pupil, that part of the pupil which is a deep black has no lens, while the part which contains the lens would be of a delicate gray. Any dislocation of the lens entails a considerable disturbance of vision. If the lens still lies behind the pupil the eye becomes very myopic because the lens is allowed to assume its maximum convexity on account of separating from the suspensory ligaments which keep it elongated when the eye is at rest. Invariably any tear in the suspensory ligament results in soft cataract. Added to this is a considerable degree of astigmatism. Dislocations of the lens usually entail secondary consequences which may be extremely disastrous to the eye, but in those cases in which the dislocation entails no further injurious consequences than the disturbance of vision, the treatment consists in prescribing suitable glasses.

Suborbital (sub-or'-bit-al). Beneath the orbit.

Subretinal (sub-ret'-in-al). Situated beneath the retina.

Subvulsion (sub-vo-lu'-shun). An operation for the removal of a pterygium.

Suction (suc'-shun). A method by which fluid is withdrawn.

Suffusion (suf-fu'-zhun). State of being blood-shot or of being moistened. A suffusion of tears is an excess of the flow of tears.

Super Cilia. (Upper hairs.) The eyebrows.

Superciliary (su-per-cil'-i-a-ry). That which pertains to the eyebrow.

Supra Choroidal Space. The space between the sclerotic and choroid.

Supraduction, Sursumvergence. The power of the superior rectus muscles.

Supraorbital (su-pra-or'-bi-tal). Located over the orbits.

Sursumduction (sur-sum-duk'-shun). The act of turning one eye up and the other down. The test is made by placing the base of prisms up or down until we find the strongest with which the eye can see an object singly.

Sursumvergens (sur-sum-vur'-jenz). A tendency upward, as in vertical squint.

Suspensory (sus-pen'-so-ry). Serving to hold up a part.

Suspensory Ligaments. The hyaloid membrane forms the hyaloid sac in which the vitreous humor is contained. It runs forward up over the ciliary body, divides and forms the suspensory ligaments, which are attached to the lens capsule. C. B. Lockwood, in a journal of Anatomy and Physiology, vol. XX., part I.—Ed. of 15th English edition, has also described a thickening of the lower part of the Capsule of Tenon, which he has named the suspensory ligament of the eye. It is slung like a hammock below the eyeball, being expanded in the centre and narrow at its extremities, which are attached to the malar and lachrymal bones respectively.

Symblepharon (sym-blef'-ar-on). Adhesion of the lids to the eyeball. This develops whenever two opposed spots of the conjunctiva of the lid and of the eyeball have raw surfaces which come into contact with each other, and in consequence become adherent. Causes which can give rise to the formation of raw surfaces upon the conjunctiva are burns by the action of heat, burns from caustic substances, diphtheria, operations, ulcers of all kinds, etc.

Sympathetic Ophthalmitis (sym-pa-thet'-ik of-thal-mi'-tis). An inflammatory condition of the iris and ciliary body, which is developed through an injury or disease of the opposite eye.

Symptoms. A perceptible change which indicates disease, or that which indicates the existence of something else. (See Objective and Subjective Symptoms.)

Synchysis (syn'-chy-sis). Liquefaction of the vitreous. When observing opacities of the vitreous with the ophthalmoscope, we see that most of them float about freely in the vitreous. From this we would assume that the framework of the vitreous must have been destroyed, so that this body itself is converted into a perfectly liquid mass.

Syndesmi'tis. That condition in which there is inflammation of a ligament or of the conjunctiva.

Synechia (syn-e'-chi-ah). Adhesion, as of the iris to the lens or cornea. **Posterior s.**, adhesions of the iris to the lens capsule. **Anterior s.**, adhesions of the iris to the cornea.

Synizesis (sin-iz-e'-sis). Contraction of the pupil of the eye.

Synophthalmus (syn-of-thal'-mus). A one-eyed monster.

Syntropic (sin-trop'-ik). Turned in the same direction.

System. The bodily organism. An assemblage of parts or organs which unite in a common function.

T. An abbreviation for tension or temperature.

Tapetum (ta-pe'-tum). The luminosity seen in the eyes of many beasts. A lustrous, greenish membrane seen in the eyes of cats.

Tarsal Cartilages (tar'-sal kar'-til-aj-es). The cartilages that give the eyelid its shape.

Tarsitis (tars-i'-tis). An inflammation involving the tarsal cartilages.

Tarsoplasty (tar'-so-plas-ty). Plastic surgery of the tarsus.

Tarsorrhaphy (tar-sor'-a-fe). An operation upon the eyelids.

Tarsotomy (tar-sot'-o-my). A surgical operation which involves the cutting of the tarsal cartilages.

Tarsus (tar'-sus). That which forms the skeleton of the eyelid, giving it rigidity of form and affording it firm support. The tarsus of the upper lid is broader than that of the lower.

- Tears.** The watery secretion of the lacrimal glands.
- Teichopsia** (tei-kop'-si-ah). A luminous appearance before the eyes, with a zigzag, wall-like outline.
- Telangiectasis** (tel-an-je-ek'-ta-sis). Dilatation of capillaries.
- Tendency** (tend'-en-cy). A disposition on the part of a muscle to incline toward certain directions.
- Tendon** (ten'-don). The fibrous cords by which the muscles are attached.
- Tenonitis** (ten-on-i'-tis). Inflammation of the Capsule of Tenon.
- Tenon's Capsule.** The capsular non-bony socket of the eye. This extends forward as far as the conjunctiva of the eyeball and backward nearly to the optic nerve. It is thus open in front and behind, and may be said to represent a broad ring placed about the eyeball. It forms the articular socket for the eyeball, which can move in it freely in all directions. (See Anatomy.)
- Tenotomy** (ten-ot'-om-e). An operation for cutting or dividing the tendon of a muscle.
- Tension** (ten'-shun). The condition of being stretched or tense.
- Tensor-tarsi Muscle** (ten-sor-tar'-si). A very small muscle located at the inner canthus of the eye. It takes its origin at the crest of the lacrimal bone, and is inserted into the tarsal cartilage of the eyelids. It is supplied by the facial nerve. Its use is to compress the puncta and lacrimal sac.

- Test.** An examination or trial. **T. types,** letters of various shapes and sizes used in testing visual power.
- Tetranopsia** (tet-ran-op'-si-a). Obliteration of one-fourth of the visual field.
- Thermometer** (ther-mom'-e-ter). An instrument for ascertaining temperatures.
- Thrombosis** (throm-bo'-sis). The formation of a blood-clot in a vessel at the point of obstruction.
- Thyroid** (thi'-roid). Shield-shaped. **T. Gland** is a vascular body situated at the front and sides of the neck, and extending upwards upon each side of the larynx. It is a single gland, varying greatly in size in different individuals.
- Tinea Tarsi.** Blepharitis marginalis. (See Blepharitis.)
- Tobacco Amaurosis.** A dimness of vision caused by the excessive use of tobacco, which acts directly upon the nervous system. The reduction in the visual acuity is almost always the same in both eyes. Treatment consists, first of all, in abstinence from tobacco, and it is probable that in light cases this alone is sufficient to effect a cure.
- Tonic Spasm.** A continuous involuntary contraction of the ciliary muscles. This condition may exist in any muscle.
- Tonometer** (to-nom'-e-ter). An instrument for measuring the tension of the eyeball.
- Toric Lens.** A lens with a sphere and a cylinder on the same side, periscopic in shape. (See page 225)

Torsion (tor'-shun). A twisting.

Toxic Amblyopia. Amblyopia caused by a poison, a common cause being excessive use of tobacco or liquor or both.

✓ **Trachoma** (tra-ko'-mah). Granular conjunctivitis. Characterized by slowly progressive changes in the conjunctiva of the eyelids, in consequence of which this membrane becomes thickened, vascular, and roughened by firm round elevations, instead of being pale, thin, and smooth. Granular disease is very important, because it greatly increases the susceptibility of the conjunctiva to take on acute inflammation and to produce contagious discharge. It often gives rise to deformities of the lid and to serious damage of the cornea. The conditions which favor the development and spread of trachoma are unclean and overcrowded surroundings in which ventilation is neglected, and the locality is damp. The disease is common among school children who are poorly nourished.

Tract. (See Optic Tract.)

Transection (tran-sek'-shun). A section made across a long axis.

Transillumination (trans-il-lu-min-a'-shun). The inspection of the interior of an organ by means of a strong light.

Transit. A passing across. A term used in retinoscopy to indicate movement of the light area.

Transitional Zone. The posterior part of the lens sac during the stage of growth.

Translu'cent. The quality of transmitting rays of light without the object being distinctly seen. (Frosted Glass.)

Transparent. Having the property of being clearly seen through.

Transposition (trans-po-si'-shun). Changing the form of an optical prescription without changing its optical value. In order that you may be enabled to give your patients glasses which give them the best possible vision, it is necessary for you to know how to build lenses which produce a periscopic effect; this periscopic effect being the prime and important feature in every instance. The term periscopic is applied to spectacles having concavo-convex lenses, which enable the eye to view with equal likeness on all sides. When lenses are not of this description the desired result may be obtained by the following rules:

When the sign of the sphere and cylinder are alike (i. e., both plus or both minus) add them together for the new sphere, prefixing the same sign.

When the sign of the sphere and cylinder are different (i. e., one plus and the other minus) subtract for the new sphere, prefixing the sign of the larger number.

ALWAYS change the sign of the cylinder to the opposite, but do not change its value.

ALWAYS change the axis to right angle (i. e., move it 90 degrees).

For transposition of simple cylinders, use the following rule: Use the numerical value of your cylinder for the new sphere, prefixing the same sign, and for the new cylinder use the same value

as the original, but prefix the opposite sign and change the axis to right angle.

To convert cross cylinders into sphero-cylinders. apply the following rule: Use the smaller number for your sphere (if the numbers are alike, take either one, keeping its own sign), and when the signs of the cylinders are alike (i. e., both plus or both minus) subtract them for your cylinder, prefixing the same sign. When the signs are unlike (i. e., one plus and the other minus) add them for your cylinder, prefixing the sign of the remaining cylinder. And also its axis.

If, after transposing cross cylinders, your prescription is not periscopic, make it so by transposing again by one of above rules.

Below find a few examples in transposition, with their answers: (See page 215.)

Example, +3 sph. \odot -2 cyl. ax. 60.

Answer, +1 sph. \odot +2 cyl. ax. 150.

Example, +2 sph. \odot +2 cyl. ax. 90.

Answer, +4 sph. \odot -2 cyl. ax. 180.

Example, +4 cyl. ax. 45 \odot +2 cyl. ax. 135.

Answer, +2 sph. \odot +2 cyl. ax. 45.

Example, -3 cyl. ax. 20 \odot +3 cyl. ax. 110.

Answer, -3 sph. \odot +6 cyl. ax. 110.

Example, +1 cyl. ax. 60.

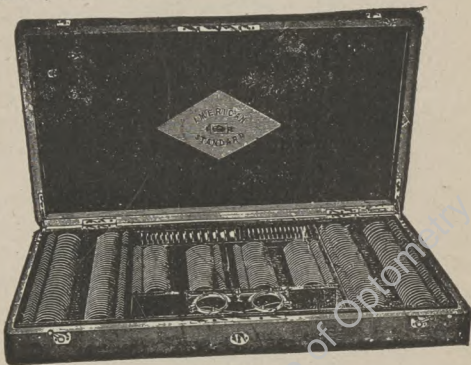
Answer, +1 sph. \odot -1 cyl. ax. 150.

Traumatic (trau-mat'-ik). Of, caused by, or pertaining to, an injury.

Trembling Eyes. (See Nystagmus).

Trial Case (and how to use it). The ordinary trial case contains about thirty pairs of convex and the same number of concave spherical lenses,

ranging from 0.12-D. up to 20-Diopters; twenty pairs of convex and the same number of concave cylindrical lenses ranging from 0.12-D. up to 6-D.; at least ten prisms from 1 to 10 degrees; a plain red tinted glass; some shades of smoked glasses; an opaque disc; stenopaic slit; pinhole disc; a ground glass disc; a Maddox rod, or double prism, and a retinoscope; two trial frames, one having three cells to be used in



Trial Case.

fitting, the other two cells, so that we may allow a patient to wear his correction for a short time and still have one to use. The patient is seated 20 feet from the test card, which must be well illuminated, and shades arranged so that the light will throw no direct rays on the patient's face. Place a small table holding your trial case on the patient's right-hand side; seat yourself at the table with your back to the reading chart. Now you will find yourself in a very easy position to change the lenses. The trial frame is placed upon

the patient's face and adjusted so that he will look through the center of the lenses, having the frame as near the face as possible. Now you are in a position to begin testing. First place the opaque disc over the left eye, always making it a rule to test the right eye first, as you will find all prescription blanks made out in this way. Now instruct your patient to read the smallest line of letters that he can see with the naked eye. We will say in this case he read the line marked 60. As he is seated 20 feet from the chart, vision with the naked eye is 20/60. You must always remember what the vision with the naked eye is, so that you will be able to judge whether or not the vision is improved with the correction. Now you take a plus sphere from the trial case, say plus .50-D., place it before the right eye, asking the patient to again read the smallest type that he can see clearly. Should the patient not read as well, the case may be one of emmetropia, myopia, or astigmatism; but, on the other hand, if he reads just the same as before, or a line better, it is a case of hypermetropia, and we will now proceed to work out a case of each kind.

HYPERMETROPIA.—Place the trial frame on the patient's face, cover the left eye with the opaque disc, and ask the patient which is the smallest line he can read correctly. In this case we will say he read line numbered 50. Then his vision will be 20/50. Now we place before this right eye a plus .50 sphere, and if the patient reads the same or a line better, it is surely a case of hypermetropia. Now, as a plus will always relax accommodation, and we do not want any eye to accommodate for 20 feet, or farther, we will add

more plus in the following manner: take a plus 1 sphere and place it in the second cell of your trial frame, then withdraw the plus .50. In this way the eye will not be left uncovered; again ask the patient to read, and should he read as well as before we will increase the plus sphere until the smallest line that he reads the best becomes blurred, then we will know that he has relaxed all the accommodation he had in use; that being the object of the fogging system. Then draw the patient's attention to astigmatic wheel, asking him, "are all the spokes in the wheel equally clear and of the same density?" If there is no astigmatism the patient will see the wheel uniformly. In that case we would ask him to again look at the reading chart, and gradually reduce the strength of the plus sphere, until we find the strongest that will allow the best vision. This will be his correction. On the other hand, had the patient told you that the wheel did not look uniform, but that one or more of the spokes were much darker, it would indicate astigmatism, and we would ask the patient which spoke appeared the most clearly. Now, suppose he says "it is the vertical," or the spoke running from 12 to 6, then as we wish to know if the patient sees the spoke quite clearly, we will ask him to count the lines in the spoke. Should he count the right number we will consider he is seeing it clearly, and to make sure that he is not still accommodating before we correct the astigmatism, we will increase the plus sphere (already in the trial frame) until we just about blur all the spokes in the wheel; then reduce your sphere a quarter D. at a time, at the same time asking the patient to

inform you when one of the spokes comes out clearly, and he can count the lines. Whatever plus sphere you have in the frame at this time, place in the cell nearest the eye; or, a better way would be to place a plus sphere of the same strength as the one already in the frame in the cell nearest the eye before removing the one in front. In this way you will move the lens in the frame without exposing the naked eye. It will then be out of the way while using the cylinder. Now take from your trial case the weakest minus cylinder and place it in the trial frame with the axis at right angles to the plainest spoke seen. Should this fail to make the wheel look uniform, increase the strength of your cylinder until you find the weakest that will make the wheel look equal in density in all its spokes. When you have done this, draw the patient's attention to the reading chart, and gradually reduce the strength of your plus sphere while it improves the distant vision. In other words, the strongest plus sphere combined with the weakest minus cylinder that corrected the astigmatism is the patient's correction for constant use.

MYOPIA.—Seat the patient as in the previous case. Cover the left eye with the opaque disc, ask him to read the smallest type he can with the naked eye, record this vision to compare it with the final correction. Now place a plus .50 in the trial frame, and if the patient is myopic he will say, "I cannot see so well," or in other words, will not be able to read the same line as before. Then draw his attention to the astigmatic wheel and say, "can you see the spokes in the wheel, and do

they look equally clear?" If he cannot see any of the spokes clearly enough to count the lines, remove a quarter D. of the plus sphere. If with this he fail to see any of the spokes clearly, remove the other quarter from the trial frame. If none of the spokes are yet clear, begin with the weakest minus sphere and gradually increase same a quarter D. at a time until one or more spokes come up clearly. If they all appear clear at the same time there is no astigmatism, and we turn to the reading chart and give him the weakest minus sphere that will allow him to read the best. This would be his correction. On the other hand, if there is astigmatism, the wheel will not come up equally clear, but some spokes will be plainer than others. The main point is not to increase the minus sphere after one or more spokes appear clearly; for instance, we will say we have on a minus 1 sphere and the patient tells us that he cannot count any lines in any of the spokes as yet. We add to this sphere a minus 25, which will make it minus 1.25, and if he says "Now I can see one spoke clearly," and it runs from 12 to 6, this is the time to begin with the weakest minus cylinder, placing the axis at right angles to the plain spoke, increasing its strength until you find the weakest that makes the wheel look uniform in density. In this case we will say that it required a minus .75 cylinder, that cylinder combined with the sphere already in the frame will be the correction, which will read as follows:—1.25 sph. \odot —.75 cyl. ax. 180.

Trichiasis (trick-i'-a-sis). That condition where the eyelashes, instead of extending forward, are directed more or less backward, so as to come in

contact with the cornea. Trichiasis causes a continual irritation of the eyeball, due to the action of the cilia (eyelashes); there is photophobia, lachrymation, and a constant sense of a foreign body in the eye. The cornea itself suffers considerable injury.

Trichitis (trick-i'-tis). Inflammation of the root of the eyelashes.

Trichosis (tri-ko'-sis). A disease of the hair. (See Trichiasis.)

Trichroic (tri-kro'-ik). That which exhibits three different colors in three different positions.

Trichromatic (tri-kro-mat'-ik). That which has three colors.

Triplet. A combination of three lenses.

Triplopia (trip-lo'-pi-ah). That condition in which there are three images of the same object formed upon the retina.

Trochlea (troch'-le-ah). A pulley-shaped part, such as that through which the superior oblique muscle passes.

Trochlearis (troch-le-a'-ris). That which refers to the superior oblique muscle.

Tumor (tu'-mor). A swelling. A growth of new tissue, differing in structure from the part on which it grows, not the result of inflammation.

Tunic. Coat or covering. The eye has three tunics; from without inward they are: first, sclerotic and cornea; second, choroid, ciliary body, and iris; third, the retina.

Funica. Same as tunic. **T. adnata**, that portion of the conjunctiva which comes in contact with the eyeball.

Futam'ina Oculi. The protecting appendages of the eye, such as the eyelids and lashes.

Fyphlol'ogy. A treatise on blindness.

Fyphlo'sis. Blindness.

Fylosis (ty-lo'-sis). A thickened, ulcerated condition of the lid margins after ulceration.

Ulcer. An open sore, other than a wound.

Ulceration (ul-ser-a'-shun). Formation of an ulcer.

Umbo (um'-bo). The apex, pointed or protuberant part of any substance. When applied to lenses, the extreme elevation of a convex spherical lens, or it may apply to the center of a concave spherical lens.

Umbra. A shadow.

Undula'tion. A wave-like motion in any medium.

Un'dulatory Theory. A theory that light, heat and electricity move with a wave-like motion.

Uniaxial (u-ne-ak'-se-al). That which has but one axis.

Unioc'ular. Only one eye.

Uremia (u-re'-me-ah). Blood-poisoning from retained urinary excretions.

Uvaeformis (u-ve-for'-mis). The middle coat of the choroid.

Uvea. The choroid, ciliary body, and iris together.

Uveal Coat. The second tunic or coat of the eyeball.

Uveitis (u-ve-i'-tis). That condition in which the uvea is inflamed. Iritis.

Uveal (u'-ve-al). That which refers to the vascular layer of the choroid coat, or the ciliary body and iris.

V. Abbreviation for vision.

Vein. A vessel which conveys blood toward the heart.

Visibility (vis-i-bil'-i-ty). That which has the capacity of being seen.

Vision. The ability of the organ of sight (the eye) to recognize surrounding objects. **Double v.**, (see Diplopia). **Binocular v.**, seeing an object with both eyes at the same time without diplopia. **Monocular v.**, the act of seeing with only one eye.

Visual. Pertaining to vision or sight. **V. Angle**, an angle formed by lines drawn from the extreme edges of an object which cross at the nodal point. **V. Axis**, a line drawn from the macula lutea through the nodal point to the object looked at. **V. Field**, the space containing all objects visible while the eye is in a fixed position. **V. Purple**, purple pigment to be found in the retina, which is bleached by the action of light.

Visual Acuteness. The amount seen by the naked eye if emmetropic; if ametropic, while wearing his correction. The smaller the objects that the eye can distinguish, or the greater the distance at which an object of given size can be seen, the greater is the acuity of vision the eye possesses.

Vitreous (vit'-re-ous). A transparent fluid occupying the posterior and interior four-fifths of the eye.

Vitreous Humor. A transparent, colorless, gelatinous mass which fills the posterior cavity of the eye. It somewhat resembles the white of an egg and is surrounded by the hyaloid membrane. (See Anatomy.) Its index of refraction is 1.33.

Virtual Focus. An imaginary or negative focus.

Woon Graefe's Sign. That condition where the lid fails to move downward with eyeball in exophthalmic goiter.

Wall-eye. This term has several meanings. It generally refers to white opacities of the cornea or a pale blue iris. Sometimes divergent strabismus.

Wave Theory. The theory that light travels in waves instead of rays. (See Light).

Wink. The act of opening and closing the eyelid suddenly.

Winker. (See Eyelash.)

Worsted Test. The common test employed for color-blindness.

Xanthelasma (zan-thel-as'-mah). That condition in which there is a flat tumor of a dirty sulphur-yellow color which projects a little above the skin of the lid. It is found most frequently on the upper and lower lids at the inner angle of the eye.

Xanthocyanopia (zan-tho-cy-an-o'-pi-ah). That condition in which there is an inability to perceive red and green colors.

Xanthoma (zan-tho'-mah). A yellowish new growth on the skin.

Xanthophane. A condition in which objects appear yellow.

Xeroma (ze-ro'-mah). That condition where the conjunctiva is abnormally dry.

Xerophthalmia (ze-rof-thal'-mi-ah). Conjunctivitis with atrophy and no liquid discharge.

Xerosis (ze-ro'-sis). Abnormal dryness of the eye.

Yellow Spot. The macula lutea.

Young-Helmholtz Theory. The theory that color vision depends on three sets of retinal fibers which correspond to the colors red, violet, and green.

Zeiss's Glands. The sebaceous or sweat glands located at the free border of the eyelids.

Zinn's Ligament. A circular ligament at the optic foramen from which arises the recti muscles of the eye; the ligament itself is attached to the bone and allows the optic nerve to pass through its center.

Zone. A girdle or belt.

Zonula. A very small membrane surrounding a body. A small zone.

Zonule of Zinn. The suspensory ligament of the eye-lens. It consists of delicate fibers which take their origin from the inner surface of the ciliary body, beginning at the ora serrata. The fibers are in contact with the surface of the ciliary body, but leave it at the apices of the ciliary processes, and, becoming free, divide and pass over to the edge of the lens, thus forming the anterior and posterior suspensory ligaments. These ligaments are attached to the capsule of the lens with which they become fused. The space, triangular in shape, included between the fibers of the zonule or suspensory ligaments and the edge of the lens is called the Canal of Petit.

Just outside of the optic nerve, where it pierces the eyeball, is found a circle of blood-vessels giving a free supply to the optic sheath at this point, and sending branches into the substance of the nerve to supply nutrition. This circle is known as the Circulus of Zinn or sometimes called a Zone of Zinn.

Zonulitis. Inflammation of the Zonule of Zinn.

RULES TO BE REMEMBERED.

No. 1. No eye should be allowed to use accommodation at 20 feet or more.

No. 2. Always give a hyperope the strongest plus that will not blur his best distant vision.

No. 3. Give a myope the weakest minus that will give him best vision. Never put minus where it does not show returns.

No. 4. After putting the patient in the fog, place the axis of your minus cylinder at right angles to the plainest line seen.

No. 5. Correct presbyopia after correcting distant vision.

No. 6. Before testing for muscle trouble correct the ametropia.

A FEW QUESTIONS WITH THEIR ANSWERS.

1. Q. What governs the passage of light through any transparent media?

A. Density.

2. Q. On what does the visual angle depend for its existence?

A. The size and distance of the object.

3. Q. What three laws accompany refraction?

A. Reflection, absorption and dispersion.

4. Q. In what three ways can an incident ray be disposed of?

A. Reflected, absorbed or refracted.

5. Q. What three laws must be brought into play in order to obtain distinct binocular vision at various distances?

A. Refraction, accommodation and convergence.

6. Q. Why is it necessary for the aqueous humor to be thinner than the vitreous humor and yet have the same density?
A. To allow freedom of movement to the iris.
7. Q. Why is accommodation and convergence so closely associated?
A. Because they are both operated by the same nerve, and must both be brought into play for the same purpose.
8. Q. What lens represents the focal strength of the dioptric system of the eye?
A. From 62 to 65-D. plus.
9. Q. When is a lens periscopic?
A. When it is minus on one side and plus on the other.
10. Q. What are objective and subjective symptoms?
A. Objective symptoms are what the operator detects without questioning the patient. Subjective symptoms are those described by the patient.
11. Q. Why does amblyopia cause convergent strabismus?
A. In order to prevent the amblyopic eye from interfering with the vision of the good eye, the patient turns the eye toward the nose.
12. Q. Why do we add and subtract from retinoscopic findings?
A. To place the patient's far point at 20 feet.
3. Q. Why is the concave retinoscope superior to the plane?
A. Because a concave retinoscope combined with a plus 20-D. lens can be used as an ophthalmoscope, while a plane retinoscope cannot,

14. Q. What lens can be combined with plus 2 sphere combined with plus 1 cylinder, axis 90, that will increase the cylinder and decrease the sphere?
- A. Any minus cylinder under 2 diopters with its axis at 180.
15. Q. What is false myopia, and how is it produced?
- A. A spasm of accommodation in emmetropia will cause the eye to appear myopic, and is brought about by continual strain at close work, exophoria or hyperopia.
-

Points one should be familiar with before attempting a State Examination.

1. Mechanical parts of frames and guards for mounting lenses; making face measurements for same; truing up bent frames and guards; adjusting same to different persons.

2. The common shapes and forms and dioptric values of lenses of different kinds; submitting ten different kinds to applicants for determination of these qualities.

3. Practical fitting with trial case, a test of the applicant's practical ability to go through these tests and accurately fit different classes of cases with lenses.

4. Shadow testing, with or without an instrument; the actual doing of this work and determining the error of refraction by the method. The mirror or instrument preferred may be used.

5. Muscle testing, and the use of muscle testing devices; a test of the applicant's ability to make these tests and draw correct conclusions from them and their showings.

6. The proper use of different optical instruments used to measure the refraction of the eyes or any surface, or the power of the muscles of the eyes.

7. Questions on the anatomy and physiology of the eyes, including muscles, nerves, tissues and their functions.

8. Questions on refraction of lenses, transposition, conjugate foci, image forming, and the media of the eye.

9. Questions in optometry, the fitting of theoretical cases embracing all conditions of refraction met in practice.

10. Questions on the muscles and their anomalies, and the meaning of the different results obtained in practical testing.

11. Questions relative to cases that lenses do not fully correct; internal or external indications of disease.

EXAMINATION QUESTIONS.

1. What is refraction, reflection, diffraction?

2. What are the principal laws of refraction, reflection?

3. Give a brief description of the wave theory of light transmission.

4. What is a ray of light? a pencil?

5. What do you understand by the following: The optical center of a lens, the center of curvature, the normal to a surface?

6. Describe a lens; name the kinds, and explain how each influences parallel rays of light, together with ametropic conditions each is used to correct.

7. What do we understand by the terms focus, virtual focus and principal focus?

8. Name three kinds of mirrors relative to their curvature of surface and tell how each influences parallel light rays.

9. Define the incident, the refracted, the reflected ray.

10. Define a one dioptré lens, and tell how you would differentiate between a plus and minus lens; also between a sphere and a cylinder.

11. What is the nodal point; the principal and secondary axis of a lens?

12. Which ray passes through the lens unchanged, and along what lines does it travel?

13. What is an angle; right angle; sine of the angle; an arc; and tell which is the greater angle, one whose arc measures 45° , or one of 90° .

14. Define the visual angle and give the size of its angle when required to show 20-20 vision at 30 feet.

15. Define the term radius of curvature; and explain the difference between the expressions "greater curvature" and "lesser curvature;" also state which lens has the greater curvature, $-5D$. or $-8D$.

16. Name three causes which contribute to the determination of the focal point of a lens.

17. How would you proceed to find the optical center of a lens, the axis of a cylinder, the base apex line of the prism?

18. Define the term "conjugate foci" and calculate the distance of the object when the image is formed at 15 centimeters, a $+ 5 D$, intervening.

19. Give the table for linear measure in the Metric System; the equivalents of the meter and centimeter in inches.

20. If the curve on one surface of a bi-convex lens is on a $13\frac{1}{2}$ inch radius and the other on a 40 inch radius, what is the power of the lens?

21. Why does a distant object, seen through a plus lens, seem to grow in size as the lens is pushed forward? and what is the action of a minus lens under similar conditions?

22. Transpose the following: -2 S. \bigcirc $+ .75$ C. ax. 75 . Write two prescriptions for a case of astigmatism, the vertical meridian -3.75 D. myopic, and horizontal -75 D. myopic.

23. Describe the difference between the image formed by the entire lens and one in which the rays must also pass through a pinhole diaphragm. State the clinical signification when the pinhole test fails to improve vision.

24. What is an image, and how is it formed, and state the position it assumes on the retina relative to the object?

25. Describe a prism; and tell how the unit of measure, the prism diopetre, is obtained.

26. By what means and how do we obtain the spectrum, and what does it teach us?

27. What is chromatic aberration? spherical aberration?

28. Which glass has the greater dispersive power—crown or flint? and which of the component rays of white light is influenced most powerfully and which the least by the laws of refraction?

29. Give a brief description of the retinoscope and the principles involved.

30. Define the character of the shadow and the direction of its movements, in simple hypermetropia, simple myopia and astigmatism, with plane mirror.

31. How many methods are there for examination of the retina by means of the ophthalmoscope, and in what particulars do they differ?

32. In the direct method with the ophthalmoscope, if you are -2 D. myopic and you get the best view of the fundus through the sight-hole, no lens intervening, and accommodation at rest, what is your patient's condition of refraction?

33. When the eye ground is examined with the ophthalmoscope, under what conditions are each of the tunics visible?

34. What is the course of light rays, reflected from the posterior part of the eye (the eye being at rest), in myopia, hypermetropia and emmetropia?

35. What do you understand by decentration of lens and its relations to the adjustment of spectacles?

36. Define pupillary distance and tell how you would measure same.

37. How would you proceed to measure for spectacles? name the principal measurements involved.

38. What constitutes the dioptric system of the eye?

39. Give the average dimensions of the emmetropic eye and the dioptric value of lens necessary to neutralize one mm. increase in length of eye beyond that in emmetropia.

40. Define the optic axis of the eye; the visual line and the angle gamma.

41. What do you understand by static and dynamic refraction of the eye? punctum proximum and punctum remotum?

42. Describe accommodation and name the several anatomical parts co-ordinating during the act.

43. How is the accommodation influenced by age? Give the powers of accommodation at 40, 45, 50, and 70 years of age.

44. What is range or amplitude of accommodation, and what do you understand by relative range of accommodation and relative range of convergence?

45. How may spasm of accommodation affect the refraction of the eye and complicate the tests therefor? Differentiate between tonic and clonic spasms of accommodation.

46. Give some of the symptoms of hypermetropia where this condition exists in a mild degree.

47. What is hypermetropia? Name the conditions of the dioptric system that may be the immediate cause of this error in refraction.

48. What is the state of refraction in myopia? Name the conditions of the dioptric system that may be the immediate cause of this anomaly.

49. What are the different tests for hypermetropia, myopia and astigmatism?

50. How would you proceed to diagnose an error of refraction?

51. Describe the cornea and its curvature of surface in detail. Give its index of refraction and name the dioptric value of one mm. varia-

tion in radius of curvature of any one meridian of the cornea.

52. What is astigmatism, and into how many classes and subdivisions is regular astigmatism divided?

53. What is irregular astigmatism, and what parts of the dioptric system are at fault?

54. What is keratometry?

55. Name the following radii of curvature: The anterior and posterior surfaces of cornea and lens, also the distance of the anterior principal focus from summit of cornea and posterior principal focus from the nodal point.

56. What is conical cornea and its effect on the refraction?

57. What constitutes perfect binocular vision? What is the fusion sense?

58. Define orthophoria and give the technical terms for each condition of heterophoria and heterotropia; and name the tests for heterophoria.

59. Define abduction, adduction, sursumduction and torsion; and name the muscles functioning in each movement.

60. How would you differentiate between concomitant and paralytic strabismus? and how do they differ in regard to subjective symptoms?

61. Define paresis and paralysis, and tell how you would diagnose either condition.

62. What is diplopia, and the cause? Define homonymous and heteronymous diplopia and describe the orientation of the false image in either condition of diplopia.

63. Name the intrinsic and extrinsic muscles of the eye, and the nerves supplying innervations to each.

64. Define convergence and its relation to accommodation. How would a prism base in affect convergence, base out?

65. Name the muscles affected in each eye by the following prescription: O. D. + 3.50 D., O. S. + 7.50 D., decentered 2mm. in at meridian 135. Denominate prismatic value at primary position of eyes.

66. What is the iris? Name its functions, also define mydriasis and miosis, naming at least three drugs producing the former and two the latter condition.

67. Define anisometropia and state how this condition, when marked, complicates the correction of refractive defects.

68. Describe the crystalline lens; name and describe its functions; give its index of refraction and the refractive effect of extraction.

69. Describe the character of the vitreous and its functions, and state whether or not the index of refraction is in excess of that of the crystalline lens.

70. What is the aqueous and its functions? how is it divided and how does its index of refraction compare with that of the cornea?

71. What is the Capsule of Tenon and its functions? What are the check ligaments and their functions? What is the trochlea?

72. Describe the optic orbit in detail.

73. Describe the function of the lids and name their muscles, with the nerves dominating

each. What are the cartilages and their purpose? What are the canthi?

74. Describe the meibomian glands and their functions.

75. Of what does the lachrymal apparatus consist?

76. In what way do the tears escape from the conjunctival sac? and with what cavities is this duct continuous?

77. Describe the ciliary muscle, its ligaments and functions.

78. Describe the sclera, and name its functions.

79. Describe the choroid, and name its functions.

80. Describe the circulatory system of the eye, and name the principal arteries and veins.

81. Describe the nervous system of the eye.

82. What is the character of the retina and its relations to the optic nerve?

83. What do you understand by acuteness of vision? Name and describe the point of most acute vision in the eye, and name the functions of the peripheral portion of the retina.

84. What is asthenopia and what causes it?

85. Describe leukoma and opacity.

86. Name the principal diseases of the optic nerve.

87. Describe the objective and subjective symptoms of glaucoma and name certain drugs that have a tendency to precipitate an attack of this disease.

88. What is the ametropic correction for a patient, age twenty years, with his near point of the vertical meridian at eight inches and the near point of the horizontal meridian at ten inches?
89. What is the correct prescription for distance for a patient, age thirty years, looking at thirteen inches, with his focus on the retina, while wearing a + 2 sph. \ominus — 3 cyl. ax. 90 and using two diopters of accommodation?
90. Does an emmetrope always have normal vision?
91. Put the following prescription back to the retinoscopic finding, after reversing the shadow from 41 inches: — .50 sph. \ominus — .25 cyl. ax. 60.
92. How do we accommodate?
93. What is amblyopia? myosis? antimetropia?
94. What is the correction for an eye, with its far-point at eighty inches and the near-point at forty inches for distance and reading at thirteen inches?
95. If a patient is presbyopic two diopters and reads without any lens at thirteen inches, what is his error of refraction?
96. What causes the shadow to reverse in retinoscopy?
97. Do we always improve sight in correcting hypermetropia? State reason for your answer.
98. How is latent hypermetropia detected?
99. Put the following prescription up in toric form, using a plus six base curve, making two crosses to show each side of the lens and the power needed in each arm.
+ 3 sph. \ominus — 2 cyl. ax. 90.
100. When a prism is prescribed for constant wear, are the eyes parallel to each other?
101. Place a lighted candle forty inches from a plus two sphere, then a distance of twenty inches to a plus one sphere, what will be the conjugate foci?

Appendix

- Amyosta'sia.** Nervous tremor of the muscles.
- Amyosthe'nia.** Failure of muscular strength.
- Anaphoria.** A tendency of the eyes upward.
- Anatropia.** That condition in which the eyes turn up.
- An'nular Muscle.** A ring shaped muscle (as the sphincter muscle of the iris).
- Arach'noid Sheath.** The delicate membrane between the dura mater and pia mater of the optic nerve and capsule of Tenon.
- Artificial Pupil.** One made by an operation (Iridectomy).
- Astigmom'eter.** An instrument for measuring astigmatism.
- Astig'mometry.** The study of measurement of astigmatism.
- Atax'ia.** Failure of muscles to coordinate.
- Atypic Hypermetropia** (at-ip'-ik). Irregular Hypermetropia caused by tumors behind the eye, exerting such a pressure on the posterior pole that the region of the macula is pushed in front of the principal focus, the eye thus becoming hyperopic. It may be caused by detachment of the retina in the region of the macula.
- Atypic Myopia** (at-ip'-ik). Progressive Myopia, caused by the elongation of the eye.
- Axial Ametropia.** Ametropia that is caused by the length of the eyeball on the optic axis.
- Axis of a Mirror.** A line which strikes the center of curvature at right angles to the surface is called its axis.
- Base Curve.** The meridian of least refraction, on the toric side of a lens.
- Basedow's Disease** (See exophthalmic goiter).
- Bi-Spherical.** A lens with a sphere on both sides.

Bruch's Glands. The lymph-follicles of the conjunctiva of the lower eyelid.

Bruch's Membrane. The inner layer of the choroid coat of the eye.

Bruch's Muscle. See Ciliary Muscle.

Canalic'ulus. A small canal or channel.

Cap'illary (hair like). Any one of the little vessels which conduct the blood from the arteries to the veins.

Cardinal Points. Points which play an important part in the course of light through a spherical surface. There are four in number. The two principal foci and the two nodal points. The first principal focus is the point from which light rays emanate and pass through a spherical lens and emerge parallel to its principal axis. The second principal focus is the point where the emergent rays cross each other when the incident rays have been parallel to the principal axis.

Caustic Curve (kaus'-tik). A curve to which the rays of light reflected or refracted by another curve are tangent.

Cellulitis (sel-u-li'-tis). Inflammation of the loose tissues of the orbit.

Centrifugal (sen-trif'-u-gal). Tending, or causing, to recede from the center.

Centrifugal Impression. An impression sent from a nerve center outwards to a muscle or muscles by which motion is produced.

Ciliary Processes. The radiating circular folds composed of a connective tissue stroma, which pass up over the ciliary body. There are about sixty or seventy in number.

Conjugate Deviation. The deviation of both eyes in the same direction.

Coquille-Plane Lenses. (plus 8D. on one side and minus 8D. on the other). MiCoquille are plus 4D on one side and minus 4D on the other. They are nearly always colored.

Corradiation (kor-ra'-di-a'-shun). A conjunction or concentration of rays in one point.

Corectomy (ko-rek'-to-me). See iridectomy.

Cyst (sist). Any sac containing a liquid. Dermoid Cyst is congenital. It is a painless, uninfamed spheroidal mass, situated generally at the outer angle of the orbit, on a level with the outer end of the eyebrow.

Decomposition of Light. If parallel rays of sunlight pass through a prism, it is not only refracted, but it is also decomposed into its various colors. This is due to the unequal refrangibility of the different colored rays which form white light, the violet being refracted the most and the red the least, thus forming the spectrum.

Deor'sumvergens. Downward turning of the eye.

Dura Mater. The outermost membrane of the brain, spinal cord, optic nerve and capsule of Tenon.

Dural Sheath. The external covering of the optic nerve.

Dynameter (dy-nam'-e-ter). An instrument for determining the magnifying power of telescopes.

Dynamometer (dy'-na-mom'-e-ter). An instrument for measuring force or power; especially the muscular power.

Dynamometry (dy'-na-mom'-e-try). The process of measuring force while doing work.

Dyslexia (dis-lex'-se-ah). Inability to read caused by a disease of the brain. Vision is good but the power to read is wanting.

Dysopsy (dys-op'-sy). Dimness of vision.

Emphyse'ma. The infiltration of air into the cellular tissues of the orbit. May be caused by rupture of the lachrymal sac.

Ephidro'sis. An excessive secretion of the sweat glands of the eyelids. It causes itching, irritation and inflammation of the skin and conjunctiva. It is difficult to cure.

Epithelio'ma. Cancer composed largely of epithelial cells and is the most frequent of malignant growths affecting the eyelid. It seldom appears before the age of forty.

Extrin'sic. Of exterior origin. E. Muscles are those on the outside of the organ.

Eye Ground. The inside and back part of the eye. The Fundus.

False Image. The image seen with the deviating eye.

Fascia (fash'-e-ah). A band or sheet of tissue connecting and investing muscles.

Focal Planes. Straight lines through the foci perpendicular to the principal axis.

Focus. The point produced by light coming to or going from a point. **First Principal Focus** is at the point the light leaves as divergent rays and emerges from the optical system as parallel to the principal axis. **The Second Principal Focus** is the point where the emergent rays cross each other when the incident rays have been parallel to the principal axis. **Negative Focus** is the point from which rays of light appear, to, but do not come from, the focus of a minus lens. **Secondary Focus.** Any focus of the secondary axis.

Fogging System. The system of fitting glasses by first making the patient artificially myopic by means of plus spheres, if they are not already myopic, the idea being to relax all accommodation before using cylinders (See page 185).

Ganglion (gang'-gle-on). A collection of nerve cells giving off nerve fibers in one or more directions. A mass of vesicular neurin in the course of a nerve, apart from the brain and spinal cord.

Gonorrhe'al Ophthalmia. The most acute form of purulent conjunctivitis. It is caused by the introduction of the urethral discharge to the conjunctival sac.

Heterophoral'gia. Pain with heterophoria.

Histology (his-tol'-o-je). The science of the minute structure and composition of tissues.

Hutchinson's Pupil. One that is dilated on one side.

Inflection (in-flek'-shun). The act of bending inward or that state of being bent inward.

Ligamentum Pectinatum. The ligaments which pass from the base of the iris to the cornea. Through its meshes pass Fontana's spaces.

Lymph (limf). A pure transparent fluid like water; a coagulable fluid in animal bodies, contained in bodies called lymphatics.

Lymphatic (lim-fat'-ik). Pertaining to, of the nature of, containing or conveying lymph.

Median. Situated in the middle. The Median line refers to the line drawn from a point between the two eyes straight forward parallel with the two eyes.

Migraine (mi-gran'). A kind of sickness or nervous headache, usually periodical and confined to the side of the head.

Monochromatic Light. The spectrum is formed by a prism dividing light into its seven colors. Such light is called Monochromatic Light.

Myitis (mi-i'-tis). Inflammation of the muscles.

Myograph (my'-o-graph). An instrument for recording the different phases, such as the velocity, intensity, &c., of a muscular contraction, with the aid of a registering apparatus.

Myography (my-og'-ra-phy). A description of muscles, including the study of muscular contraction with the aid of a registering apparatus.

Myology (my-ol'-o-ji). A description of the muscles of the human body.

Myologist (my-ol'-o-gist). One skilled in that part of anatomy which treats of muscles.

Myositis (my'-o-si'-tis). Inflammation of the muscles.

Muller's Muscle. Bands of circular fibres situated internal to the radiating muscles in the ciliary body. They are sometimes called the "ring muscle" of Muller. **FIBRES OF MULLER—**Are the radiating fibres which pass through nearly the entire thickness of the retina, supporting its different layers and binding them together. They form at one end the membrana limitans interna and at the other end the externa.

Negative Convergence. The act of turning the eyes outward from parallelism, by means of the external recti muscles which turn the eyes outward.

Neurasthenia (nuras-then-i'-ah). Exhaustion of nerve force.

Nodal Points of a Lens. The two points of the principal axis, so situated that every ray which, before being refracted, is directed toward the first of them, seems, after its refraction, to come from the second one, and take a direction parallel to that which it had at first. These two parallel rays are called lines of direction, and act, in the combined system, the same part as the line passing through the nodal point of a single refracting surface.

Occipito-Frontalis. The muscle which lifts the eyebrows upward. Supplied by the seventh nerve.

Ocellus (o-sel'-ius). A single eye.

Ophthal'mia Neonato'rum. A form of purulent conjunctivitis which attacks newly born children.

Optical Center of a Lens. The center of refraction. It is found by making two parallel radii of curvature, and connecting the points in which they meet the surfaces. The point at which this line cuts the principal axis, is the optical center.

Optology (op'-tol-o-ge). See optometry.

Orb. A spherical body.

Paracente'sis. Surgical puncture of a cavity.

Perimetry (pe-rim'-et-re). Measurement of the visual field.

Pia Mater. The innermost membrane of the brain and spinal cord, optic sheath and capsule of Tenon.

Polariscope. An instrument used in showing the phenomena of the polarization of light.

Principal Planes. Straight lines which pass through the principal points, perpendicular to the principal axis.

Recomposition of Light. The reuniting of the colors of the spectrum so as to produce white light. It is done by placing a second prism exactly like the first with its apex turned in the opposite direction. The light will be recomposed and will emerge from the second prism as white light.

Ret'rosopic Lens. A lens that is tilted inward at the top.

Rules for Refraction. In order to obtain the radius of curvature of any media multiply the focal length desired by the difference of the index in the two media.

TO FIND DIOPTRIC VALUE OF ANY SURFACE

—Multiply the difference of the index of refraction by the number of meter curves in the radius of curvature and give it the sign of the curve of the denser media. Remember two meter curves in optics means one-half and three meter curves, one-third of a meter and so on.

TO FIND THE ANGLE OF REFRACTION—

Divide the angle of incidence by the index of refraction of the second media.

Sclerotomy (skle-rot'-o-me). Surgical incision of the sclera.

Se'cant (In Geometry). A line that cuts another, or divides it into parts. The secant of a circle is a line drawn from the circumference on one side to a point on the outside of the circumference on the other.

Spectrum (spec'-trum). The seven primary colors of which light is composed, separated after passing through a prism together form the solar spectrum. The colored rays of which light is composed become separated by the refraction of a prism or other means. Of the seven colors which form the spectrum Violet is refracted the most, then Indigo, Blue, Green, Yellow, Orange and Red the least.

Diffraction spectrum is a spectrum produced by diffraction.

Chromatic spectrum is the visible colored rays of the solar spectrum, showing the seven principal colors in their order and covering the larger portion of the space of the whole spectrum.

Supra-orbital Foramen. A small passage in the Supra-Orbital Ridge through which passes the supra-orbital nerve (a branch of the fifth) artery and vein.

Tangent (tan'-gent). (In geometry). A line which touches a curve at right angles to its surface, but does not cut it. (In trigonometry the tangent of an arc is a right angle line touching the arc at one extremity, through the center and through the other extremity.)

Tropom'eter. An instrument for measuring the movements of the eye.

Transposition

To transpose an optical prescription is to change the form or shape of the lens without changing its optical value.

Writing a prescription from a cross is not transposing. We must first have a written prescription before it can be transposed.

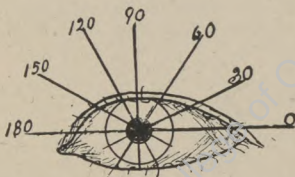
In order that you may be able to give your patients glasses which give them the best possible results, it will be necessary for you to know how to build lenses of different shapes, for instance:

Biconvex, biconcave, plano convex, plano concave, periscope and toric.

Lenses have two kinds of power, minus and plus,—the former being thinner in the center and the latter thinner at the edge. These lenses can be made up as a sphere or cylinder.

A sphere is a lens with the same power in all its meridians.

A meridian is any straight line drawn from edge to edge over its optical center.



Cut showing how the meridians of an eye are numbered from right to left.

The optical center being a point in line with the thickest part of a plus and the thinnest part of a minus lens.

A cylinder is a lens with power in all meridians but one, this one, having no power and is called its axis. The full power of a cylinder is always found at right angles to its axis.

In the following diagram we will use a plus four sphere and plus four cylinder for example:



Notice that the power is the same in all meridians of a sphere, while those of a cylinder vary in power.

An optical prescription is nothing more than an order for a lens of a given power and shape, and when it is transposed, the shape is changed but not its optical value (or power); for instance, we take the following prescription:

$+4$ sph. \odot $+4$ cyl. ax. 180

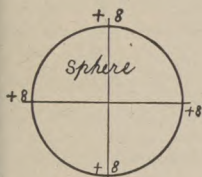
which reads plus four sphere combined with a plus four cylinder, axis 180. The optician, on receiving this prescription, will grind the plus four sphere on one side of the lens and a plus four cylinder on the other and cut it out, so that the axis of the cylinder will be at 180 degrees. This lens being plus on both sides is known as a biconvex lens.



In this example we have the sphere and cylinder separated and together, showing their combined powers and also their appearance from the side. It should be noted that the sphere does not change its value under the axis of the cylinder, thus, forming one of its principal meridians.

In order to change the shape of this lens, we must apply the following rule:

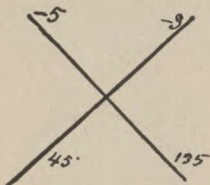
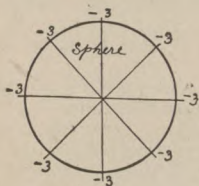
When the signs of the sphere and cylinder are alike, that is, both plus or both minus, add the values together for your new sphere which would be plus eight, then change the sign of your cylinder, which makes it minus, but do not change its value. Change its axis 90° taking 90 from 180 leaves 90 , thus $+4$ sph. $\odot +4$ cyl. ax. 180 transposed gives you $+8$ sph. $\odot -4$ cyl. ax. 90 . In the latter prescription you have what is known as periscopic lens, one side plus and the other side minus.



This shape lens is much preferred by the Refractionist of to-day on account of its appearance and comfort to the patient.

Prescription No. 2: — 3 sph. \ominus — 2 cyl. ax. 45.

This prescription calls for — 3 sph. and a — 2 cyl. to be ground together.

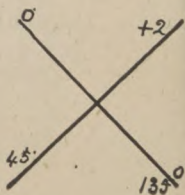


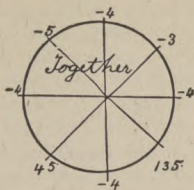
This diagram shows the sphere and cylinder separate and together and their appearance from the side. This lens being concave on both sides is known as a biconcave lens.

In order to make it periscopic we will use the same rule as before as the signs are alike.

Prescription: — 3 sph. \ominus — 2 cyl. ax. 45.

Transposed: — 5 sph. \ominus + 2 cyl. ax. 135.

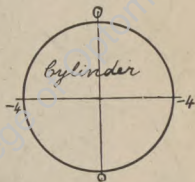
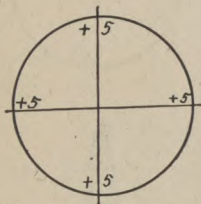




That is when the signs are alike add the values together for the new sphere, which will be -5 , keeping the same sign. Change the sign of the cylinder, but not its value and change its axis $90'$ (by adding 90 to 45). This gives us an axis of $135'$.

When your prescription reads minus and plus your lens will be periscopic.

A prescription thus: $+5$ sph. $\ominus -4$ cyl. ax. 90 , will



be ground, and in order to change its shape it must be transposed by the following rule:

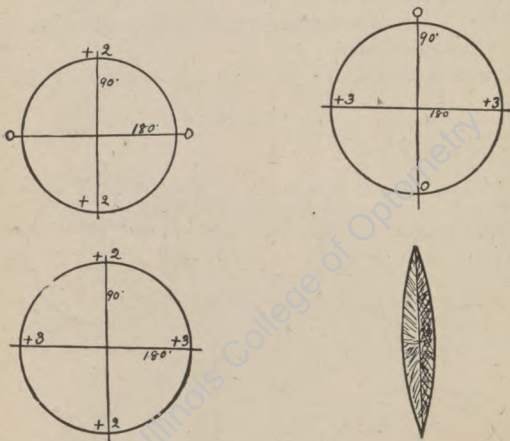
When the signs are unlike that is, one plus and the other minus, subtract for your new sphere thus:

Example: $+5 \text{ sph. } \ominus -4 \text{ cyl. ax. } 90^\circ$.

Transposed: $+1 \text{ sph. } \ominus +4 \text{ cyl. ax. } 180^\circ$.

prefixing the sign of the larger number and change the sign of your cylinder, as it was minus we make it plus, but do not change its value. Change the axis 90° but never let your axis run above 180° . If your axis was above 90° subtract 90° from it and you have right angles. On the other hand, if the axis was below 90° you add 90° to it.

Cross cylinders $+2 \text{ cyl. ax. } 180^\circ \ominus +3 \text{ cyl. ax. } 90^\circ$ in this prescription we have two cylinders with their

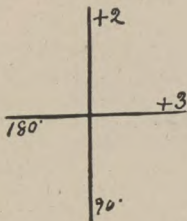
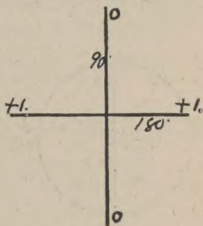
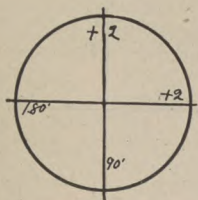


axes at right angles to each other, and it will be noticed that the power of one cylinder lies on the axis of the other. In this way, both cylinders keep their full value. In order to transpose cross cylinders into spherocylinders (if the signs are alike) take the smaller cylinder and call it a sphere and forget its axis altogether. Then

take the difference between the two for the new cylinder keeping the same sign and axis.

Example: $+2 \text{ cyl. ax. } 180^\circ + 3 \text{ cyl. ax. } 90^\circ$

Transposed: $+2 \text{ sph. } \odot + 1 \text{ cyl. ax. } 90^\circ$



Simple Cylinders

Example: $+2$, Cylinder axis 90 degrees.

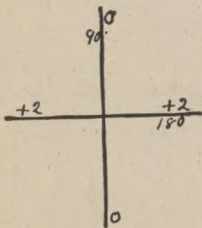
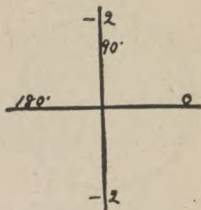
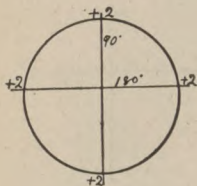


In order to transpose this prescription, just call the cylinder a sphere of the same value and combine with

it a cylinder of the same value, but the opposite sign, and change its axis 90 degrees.

Example: +2, Cylinder axis 90 degrees.

Answer: +2, Sphere, combined with - 2, Cylinder axis 180 degrees.



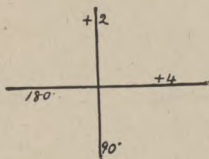
These cuts show the two lenses separate and combined, and also the side view.

Neutralizing is doing away with power in lenses by the act of placing minus and plus together. Putting lenses with the same sign together, their values add, but when the signs are different, they neutralize, leaving the difference between the two, with the sign of the larger number. This fact must be remembered when combining lenses.

Every cylinder has one flat or plain meridian, which is called its axis. Right angles to its axis it has its greatest curvature (or power), and whenever a cylinder is placed on a sphere, the sphere will keep its value at the meridian which is covered by the axis of the cylinder. It depends upon the power of the cylinder what change will be made in the sphere at the meridian, right angles to the axis of the cylinder.

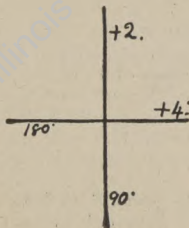
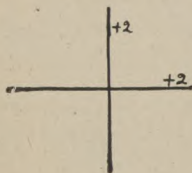
To write a prescription from a cross, take the power that is written on either arm with the same sign for your sphere. This being a sphere, it will put the same power in all meridians and if the powers on the arms of the cross are different, it cannot correct them both, and the cylinder that you use must represent the difference between the two.

In this case, we will take the plus two for the sphere.



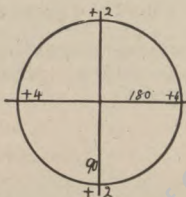
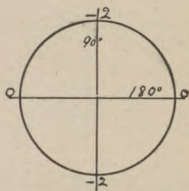
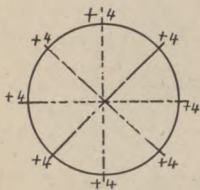
This will correct the vertical or ninetieth meridian, while it will under-correct the horizontal by two diopters, which will call for a plus two cylinder, axis ninety degrees, combined with the plus two sphere.

Example: +2.00 Sphere combined with +2.00 Cylinder axis 90 degrees.

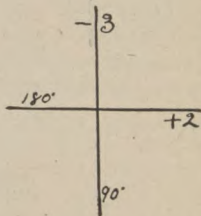
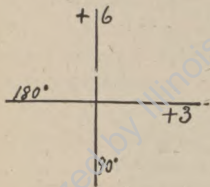


These two combined together give us the same power as that called for on the cross.

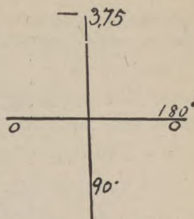
When we take the plus four for the sphere, we over-correct the vertical meridian by two diopters, therefore, it will be necessary to combine a minus two cylinder axis 180 degrees in order to get the desired result.



A few examples:



+6 Sph. \ominus -3 Cyl. ax. 90' —3 Sph. \ominus +5 Cyl. ax. 90'
 +3 Sph. \ominus +3 Cyl. ax. 180' +2 Sph. \ominus -5 Cyl. ax. 180'



+3 Cyl. ax. 45

- 3.75 Cyl. ax. 180.

+3 Sph. \ominus -3 Cyl. ax. 135.

- 3.75 Sph. \ominus + 3.75 Cyl. ax. 90.

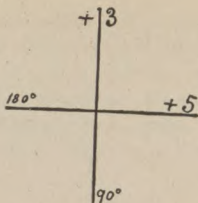
The Advantages and Make of Toric Lenses

The word toric was taken from the word torus, which means in architecture the large semicircular molding used in the bases of columns, and the term is applied to a lens having curvature in all meridians, but of different amounts, on the same side of the lens with its meridians of greatest and least curvature at right angles to each other. The other side of the lens may be either plano, concave or convex; but they are usually made extra deep periscopic.

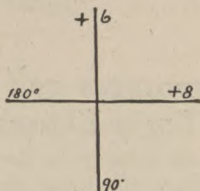
To give an idea of the appearance and proper uses of such lenses, I will put up prescriptions for the five subdivisions of ametropia which can be corrected by lenses in toric form. This can best be explained by diagrams.

The first prescription will be for compound hyperopic astigmatism + 3 sph. \ominus + 2 cyl. ax. 90.

This lens when ground must refract plus three diopters in the ninetieth and plus five diopters in the one hundred and eightieth meridians, independent of its shape.

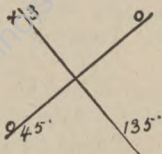


But in order to get a deep periscopic effect, the advantage of which I will explain later, suppose we grind one side of the lens thus:



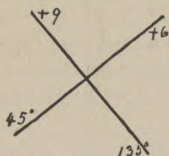
The difference between the curvatures in the two meridians gives us the desired value of the cylinder and on the other side we will grind a minus three sphere, which will neutralize plus three from all meridians, leaving the lens with the required strength. In this lens you get a plus sphere and a plus cylinder and at the same time, if a cement scale is required, it can be placed next to the eye.

The next is a prescription for simple hyperopic astigmatism: +3 cyl. ax. 45.



In this lens you require plus three diopters in the one hundred and thirty-fifth meridian and no power in

the forty-fifth meridian. The difference between the two being three diopters, on one side of the lens we will grind

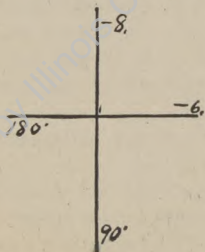


plus six diopters in the forty-fifth meridian and plus nine diopters in the one hundred and thirty-fifth meridian, and on the other side enough minus sphere to neutralize all the power from the forty-fifth or weakest meridian, which will be a minus six sphere, leaving the lens the required strength and shape.

Prescription for compound myopic astigmatism:
- 2 sph. \odot - 2 cyl. ax. 180.

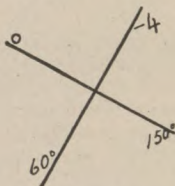


This prescription calls for a minus two diopters in the one hundred and eightieth meridian and minus four diopters in the ninetieth; the value of the cylinder being two diopters. We will grind on one side minus six diopters

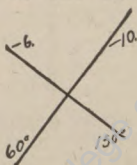


in the one hundred and eightieth meridian and minus eight diopters in the ninetieth meridian, leaving the cylindrical value of 2 D. between the two; on the other side we grind a plus four sphere. This will give us the desired result in toric form.

Prescription for simple myopic astigmatism: - 4 cyl. ax. 150.



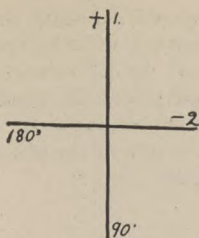
This prescription calls for minus four in the sixtieth meridian and no power in the one hundred and fiftieth meridian; the difference in the two neutralizes four diopters. We grind on one side minus six diopters



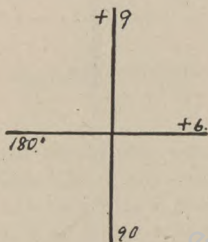
in the one hundred and fiftieth meridian and minus ten diopters in the sixtieth meridian; and on the other side we grind a plus six sphere which will neutralize minus six diopters from all meridians, leaving the lens the desired strength and at the same time give us a deep periscopic lens.

Prescription for mixed astigmatism: + 1 sph. \odot - 3 cyl. ax. 90.

This prescription calls for a lens that is plus one diopter in the ninetieth meridian and minus two diopters in the one hundred and eightieth meridian.



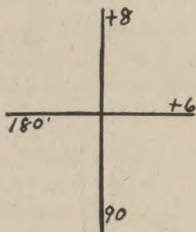
The difference between the two principal meridians being three diopters, we will grind on one side of the lens a plus six diopter in the one hundred and eightieth meridian and plus nine diopters in the ninetieth meridian:



On the other side we will grind a minus eight sphere which will neutralize all the plus from the one hundred and eightieth meridian (leaving minus two power) and plus eight from the ninetieth meridian, leaving plus one diopter, the desired strength required.

It will be noticed that I have used a plus six or a minus six for the weakest curve on the toric side. This is known as the base curve, and it is used in eighty per cent. of the toric lenses to-day, as this permits the wholesale houses to carry a stock of lenses with the toric curves already ground, thus cheapening the prices of toric work.

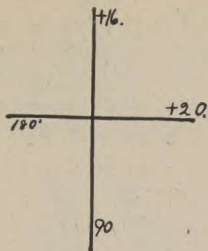
Very often prescription houses receive prescriptions calling for a toric sphere, when an extra deep periscopic lens is required, but not of toric shape, which would cost four times the price. For instance, suppose we require a plus two sphere and order it toric. It could be made plus six in one of its principal meridians and plus eight in the other.



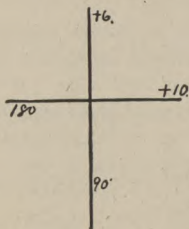
And on the other side minus four diopters in one meridian and minus six in the other meridian. The two sides combined would give the desired result, a plus two sphere, but it would be a very expensive form whereas it would be only one-fourth the price if it were to be ground as a plus six sphere on one side and minus four sphere on the other, which would be the same dioptric value. It is never advisable to order real toric spheres.

When lenses of high power are required, say + 16 sph. \odot + 4 cyl. ax. 90, it is best to divide the power in the following manner, and at the same time obtain a toric lens.

The prescription calls for plus sixteen diopters in the vertical meridian and plus twenty diopters in the one hundred and eightieth meridian.



We will grind on one side of the lens, plus six in the 90th meridian and plus ten in the 180th; and on the



other side a plus ten sphere, which would give the desired result. The same may be done with strong concave lenses, this making them biconcave.

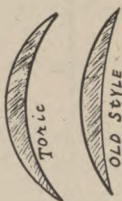
When a toric lens is desired, it is not necessary for the refractionist to mention the curvature. For the sake of simplicity, just write the word "toric" beneath the description of the lenses in your prescription. Then write the prescription in the usual way.

Toric lenses are more expensive than the old form of lenses, but on account of their superiority they are coming more into general use.

In the first place they allow a greatly enlarged field

of vision, by allowing the patient to roll the eye and at the same time see through the edges of his lens.

With lenses of the ordinary type, when an eye turns it looks obliquely through them and obtains a prismatic effect that is not desired, causing the image to be more



or less distorted on the retina, and at the same time the patient is bothered with reflection from the back of the lenses of objects on the side. With deep periscopic lenses, the curve coincides approximately with the arc formed by the eye in turning and the eye is looking much more directly through the lens and obtains a much larger field of vision without the prismatic effect.

The diagrams will show the shape of the two kinds of lenses from the same prescription, $+ 2$ sph. $\ominus - 1$ cyl. ax. 90.

Again, the edges of the lenses come nearer to the face, thus adding to the patient's appearance. The result of a lens of this description is freedom and comfort to the wearer, so much so that the extra cost should not be considered.

When a cement bifocal is required the toric side should always be plus, so that a minus sphere will be next to the eye, on which the scale may be cemented.

MEMORANDUM

Healthway Lense Co.,

Topeka, Kans.

Fast "F" and "A" Slow "S" and "R"

2 oz Chloride of Lime } allow to stand
3 oz water (Rain) } 12 hrs

Pour off water and add to it

$\frac{1}{2}$ oz acetic acid 36%.

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